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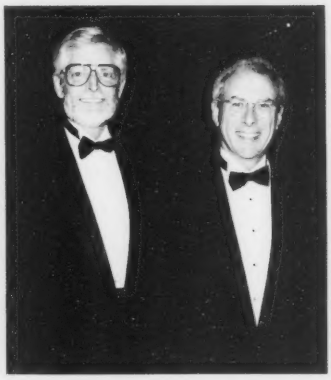
from the administrator



Seven years ago, on an empty field in Houston, a visionary looked out and saw a place to tell the story of how America goes into space. That man was Hal Stall.

The following remarks were made by Administrator Goldin at Space Center Houston during grand opening festivities. (Pictured above with Goldin is Hal Stall, director of Public Affairs at JSC.)

Texas has always had its share of pioneers and visionaries. One was Sam Houston. Where others saw obstacles, he saw opportunity. But Houston could hardly have imagined that 100 years after his death, his name would be the first word spoken from the plains and dust of another world—as Apollo 11 landed on the Moon.

Seven years ago, on an empty field in Houston, another visionary looked out and saw a place to tell the story of how America goes into space. That man was Hal Stall. Through his persistence and drive in building the necessary community and corporate support, we can now dedicate this educational extravaganza that's truly the closest thing to space on Earth.

With Space Center Houston, we have a place where students can touch, and hear, and see what space is all about. They can look inside a Space Shuttle cockpit, then try to land one on a simulator. They can watch astronauts train, see historic spacecraft, touch a moon rock, and learn what the future will look like.

Every generation has had its worlds to explore. Human beings have never possessed a technology for travel that they have refused to use. First there was journeying to the world beyond the tribal village. Then the continents. Then the oceans. Then the North Pole and South Pole. Then into the air, through the sound barrier, and on to the Moon.

Exploration is not simply a pastime for the curious, it's a biological imperative—wired right into our DNA. There is something intrinsic to life itself that says, "To grow is to live; to stop is to die." Exploration is part of what we live for. It's how we grow as intelligent beings.

Destiny is not what calls us to explore space; our humanity does. We have barely begun to break the bonds of gravity that once chained us to Earth.

The American rocket pioneer Robert Goddard once wrote to H.G. Wells: "There can be no thoughts of finishing, for aiming at the stars, both literally and figuratively, is a problem to occupy generations, so that no matter how much progress one makes, there is always the thrill of just beginning."

In the coming years, we can send orbiters and landers to the planets. We can extend human presence in the solar system, breaking the bonds of gravity to spread our species to the Moon, Mars, and beyond.

The science we'll gain from these robotic and human missions to other planets will ultimately support Mission to Planet Earth. For it is by comparing the data of what's happening on Earth right now to what has already happened elsewhere in the solar system that we can hope to fully understand our own planet.

This quest for knowledge inspired T.S. Eliot to write, "We shall not cease from exploration and the end of all our exploring will be to arrive where we started and know the place for the first time."

Space Center Houston was built for the benefit of future generations. People will come by the millions—to learn—and to have their faith renewed in the goodness and ingenuity of humankind. This living, breathing, growing facility shows the courage of the men and women who ride chariots of fire across the sky and blaze new trails for this nation to follow.

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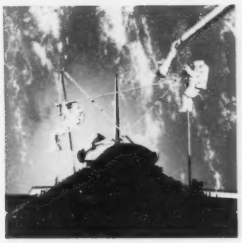

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Cover: Left to right, Rep. Jack Brooks, JSC Director Aaron Cohen, and NASA Administrator Dan Goldin cutting the ribbon at the grand opening ceremony of Space Center Houston in October. On the back cover, left to right, are Houston mayor Bob Lanier and Rep. Mike Andrews. Photo courtesy of Bill Ingalls, NASA Headquarters.

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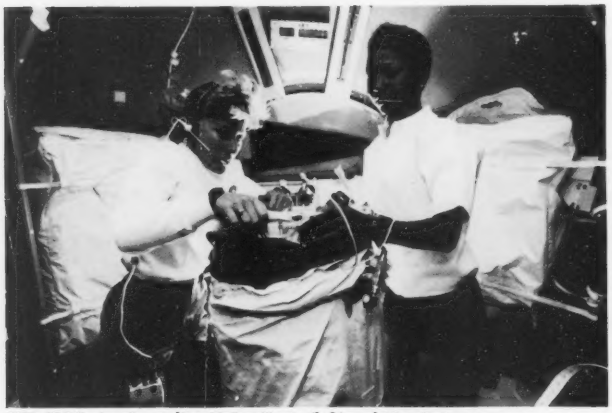


STS-47 Mission Specialists N. Jan Davis (left) and Mae C. Jemison prepare to deploy the lower body negative pressure apparatus in the science module aboard Endeavour.

Endeavour Sets Ambitious Pace...

Orbital science got a big boost September 12 when Endeavour and its crew of seven lifted off from the Kennedy Space Center to kick off the STS-47 mission. Onboard the U.S.-Japanese Spacelab-J flight were 43 Spacelab experiments in materials science and life science, along with nine Get Away Special experiments.

In one remarkable bit of televised research, the crew released several frogs from their restraining containers into a glove box as part of an experiment to help understand space motion adaptation. Once freed from their confining containers, the frogs leapt and tried to swim in an amazing display of physical disorientation. The glove box will be a standard feature aboard the Space Station.

Japanese payload specialist Mamoru Mohri spent part of the mission working with an acoustic levitation furnace to develop a type of non-silicon glass that could have a tremendous payoff in the field of infrared optical transmission using fiber optical cables. The crew also found time to engage several school groups and amateur radio clubs in two- or three-way "live from space" conversations, including one involving mission specialist Mae Jemison and school children in Chicago, which was broadcast over Chicago superstation WGN.

The STS-47 crew managed their flight so well that they coaxed an extra day in space out of the mission planners in Huntsville and Houston, to the delight of scientists whose experiments were extended. Endeavour landed at Kennedy on Sunday, September 20, after which mission manager Aubry King declared the flight an "overwhelming success."

...and Columbia Follows Suit

Just over a month after Endeavour's return, the six- member STS-52 crew lifted off on Columbia October 22 for another ambitious international science and engineering flight. The payloads included the Italian Laser Geodynamics Satellite II, which was boosted into its planned 5,700-kilometer-high orbit.

Canada has been developing a "space vision system" to enhance the performance of Space Station crewmembers using robotic arms and other servicing devices. The STS-52 mission gave NASA and Canadian Space Agency engineers a first-hand look at how the system would perform as Columbia crewmembers, led by CSA payload specialist Steve MacLean, put the system through an exhaustive set of tests over several days using Columbia's robot arm.

The crew also activated several trailblazing experiment packages flown as part of the U.S. Microgravity Program, which allowed ground investigators to observe their experiment results while tweaking the experiment hardware themselves for the first time. Results obtained from the experiments are expected to make major contributions to the fields of condensed matter physics and materials science.

Data from the Lambda Point experiment onboard STS-52 will be used to test a Nobel Prize-winning theory that attempts to explain the dynamics of matter at phase transition points. The results of these analyses could have implications across a wide range of problems in physics—including those associated with superconductivity and the development of liquid crystals.

The STS-52 MEPHISTO experiment used a directional solidification furnace for more materials science experiments. The use of real-

time data telemetered to the ground science team enhanced the use of the facility and allowed the furnace team to take advantage of extra quiet periods in the Shuttle's microgravity environment. The device represents the next generation of orbital materials science furnaces.

After nearly ten days of pioneering science and engineering, the crew landed October 31 at Kennedy's Shuttle Landing Facility. The stalwart spaceship Columbia racked up more than 4.1-million miles during the mission, bringing the total number of Shuttle orbit-miles traveled to more than 120 million since the Shuttle's debut in 1981.

Hubble Continues to Delight and Amaze

A striking Hubble Space Telescope picture showing a mirror image of a distant galaxy produced by a gravitational lens was presented in October by Richard Ellis of England's Durham University. The photo, taken by Hubble's Wide Field/Planetary Camera, clearly showed the lens effect proposed by Albert Einstein. By measuring the bending of light caused by gravity, Ellis and his team can estimate the mass and distribution of matter in the intervening space between the source galaxy and Earth. This method may be able to aid in the search for elusive "dark matter" in the Universe, since any intervening matter doesn't have to emit light to be measured.

In November, another Hubble investigator, Walter Jaffee of the Leiden Observatory in The Netherlands, presented the first image ever taken of a giant dust disk surrounding a suspected black hole. The Hubble image clearly showed a saucer-like disk surrounding galaxy NGC 4261. Although the phenomenon of galactic accretion had long been linked with black holes in theory, it had never before been seen. Jaffee and his team cautioned that the photo does not prove conclusively that black holes exist, even though this is the best evidence yet. He and others expect to use spectroscopic studies to follow the motion of gas within the center of NGC 4261 after the Hubble telescope is repaired in 1993. Such studies might allow for the final, positive, proof of a black hole by accurately measuring the mass, and therefore gravity, of the object at the core of the accretion disk.

Venus Scientists Lose One, Tweak Another

The Pioneer Venus orbiter ceased transmitting on October 8, probably because of frictional heating and burning of its antenna and other extended parts of the spacecraft as it skimmed through the upper portion of Venus' thick atmosphere.

The Orbiter had been in Venus orbit since December 1978, where it provided scientists with the first nearly-complete topographic map of the planet. A companion four-probe spacecraft entered the Venusian atmosphere in 1978.

The veteran Orbiter had been predicted to drop in its orbit last year, and scientists at the Ames Research Center and their university colleagues used the opportunity to make last minute measurements of the planet's upper atmosphere. The data are expected to answer questions about the complex interactions between the planet's atmosphere and the solar wind.

With one Venus orbiter gone, scientists working on the Magellan project focused their remaining mission lifetime on filling in the blanks in radar coverage of the surface and in providing a finely detailed gravity map, using the altimeter mode of the radar instrument, to help assess what may lay beneath some of the planet's more interesting landforms. JPL mission controllers lowered Magellan's orbit by about 75 kilometers to enhance the resolution of its fourth mapping cycle. The mission is expected to end this spring.

Hurricane Victims Get Quick Assist

NASA was among the many federal agencies that helped victims of Hurricane Andrew and Hurricane Iniki last summer. While the Stennis Space Center flew a remote-sensor-equipped Learjet over south Florida to provide state officials with digital imagery of damage caused by Andrew, emergency preparedness staff from the Kennedy Space Center provided relief supplies, including

PHOTO COURTESY OF BRUCE BUCKINGHAM, KSC

KSC's Cal Staubus, Fire and Rescue Office Chief, prepares to lead a convoy of trucks and cars to south Florida following the devastation by Hurricane Andrew.

much-needed fresh water, to hurricane victims. Disaster aid teams at Kennedy quickly dispatched several 5,000-gallon water tankers, along with emergency equipment the center had on hand in case of hurricane damage at the Space Center, to Dade County officials. The KSC relief equipment also included tool boxes, wire fencing, a hoist and generators, and food, sleeping gear and clothing.

KSC employees also pitched in to help the quarter-million newly homeless victims of Hurricane Andrew by donating baby products and baby food, canned food items, camping gear, flashlights and personal hygiene items. A packaging specialist at the Center also helped to prepare food packs sized for small, medium and large families to help speed up the distribution of these much-needed items.

When Hurricane Iniki hit the western Hawaiian islands later in the summer, pilots from the Ames Research Center flew photographic reconnaissance missions over the islands to help assess the damage. The NASA ER-2 aircraft flew regularly for nearly a week from a temporary base on Oahu.

RISC-y Business

In an effort to reduce the cost of supercomputing power and make it more readily accessible to a wider variety of researchers, computer scientists at the Lewis Research Center assembled for the first time this October what they called the world's most powerful array of RISC workstations. RISC stands for "reduced instruction set computer" and differs from the average computer chip in that it responds to only a few dozen built-in commands such as "move, add, shift, goto." The command set for the average chip that runs your trusty desktop machine—for example, the Intel 80486 or the Motorola 68040—can number in the hundreds. The advantage of RISC machines is that even though they can't do very much, they do it blindingly fast.

The Lewis center installed a networked set of 33 IBM R/6000 workstations—the most powerful personal workstations currently available. The combined power of the array gives it the capability to make up to a billion floating point calculations (FLOPS) a second. Intel and Motorola processors are rated up to several hundred million FLOPS. The new Lewis system can be set up for both distributed processing and parallel processing.

One of the workstation array's first challenges will be to completely simulate the supersonic airflow through a fan-jet powerplant. For this task, the 33-workstation system will be set up as a distributed array, with individual stations computing the airflow through specific elements of the engine. This is the first step in a greater challenge by Lewis computer scientists to completely simulate the supersonic performance of an aircraft in computerized "flight."

Earthwatch

Researchers from NASA's Wallops Island Flight Facility have discovered an unexpectedly high level of phytoplankton productivity in the Pacific Ocean near the equator. The scientists had been expecting to see limited plant productivity in the Pacific, but instead found concentrations of phytoplankton five to six times higher than those typically found in the Atlantic. The researchers used the Wallops P-3B aircraft flying the Airborne Oceanographic Lidar and other remote sensing instruments. The scientists attribute the high concentration to unusual ocean circulation patterns that would have built up the nutrient source for these single-celled plants. The research flights were part of the Joint Global Ocean Flux Study co-sponsored by the National Science Foundation. Data from this and other similar flights will be used to provide analytical tools to help refine and correlate data obtained from satellites being developed for the Mission to Planet Earth program.

In another study related to Mission to

Planet Earth, a research team from the Langley Research Center has begun monitoring the chemical composition of the atmosphere over the southern tropical Atlantic Ocean and the adjacent African and South American continental land masses. The investigation is part of the center's continuing investigation of global tropospheric chemistry.

Practicing for Mars

A five-member science team in Antarctica hopes to advance our knowledge of how Earth and Mars might have evolved. The team, which includes members from the NASA Ames Research Center, the University of Nevada and the Desert Research Institute were to spend two months from October through December in the frozen-lake valley around Lake Hoare on Ross Island. The joint NASA-National Science Foundation project follows an earlier agreement between the two agencies to advance planetary geoscience knowledge and to explore technologies that the NSF could possibly apply to ongoing polar research programs.

The five-member team includes Ames researchers Carol Stoker, Don Barch and Dale Anderson. In an example of "telepresence," the team is using head-mounted pointing and seeing devices to remotely control television cameras on vessels exploring beneath ice-covered Lake Hoare. The ice-covered lakes had been found in previous expeditions to offer clues about the evolution of life on Earth. Antarctica is the most Mars-like of any terrestrial location, and it affords a superb testbed for developing technology for future planetary exploration programs.

Experiment Express

Space Station Freedom chief scientist Robert Phillips has announced a new program designed to help researchers fly their experiments onboard the station more easily. The new program, called EXPRESS (Expedite the Processing of Experiments on Space Station Freedom), will allow investigators to take advantage of existing station hardware and will reduce paperwork associated with station experiments.

The agency also recently awarded approximately $15 million in annual funding to 119 microgravity researchers to develop the Space Station's research potential. The grants represent a 70 percent increase in the number of investigators working in the microgravity research field. The awardees represent scientists from 60 universities, eight corporate or private laboratories, five other government research institutions and four NASA centers.

In more good news for experimenters, the Get Away Special program is again accepting new applications for payload reservations. The program offers standard canisters to customers who wish to perform scientific or engineering research activities in space, at prices ranging from $8,000 to $27,000. Educational institutions can qualify for price-buster rates ranging from $3,000 to $10,000. The payloads all fly on a space-available basis within the Shuttle's cargo bay. The Get Away Special program so far has flown 87 containers in its 10-year history.

Like Father, Like Daughter

Although she may not be quite the daredevil her father was, Reeve Lindbergh, youngest daughter of Anne Morrow and Charles Lindbergh, is another kind of hero. Besides being a poet, teacher, mother and wife, she's also Vice President of the Charles Lindbergh Fund, an organization dedicated to honoring her father's memory by furthering his vision of maintaining a balance between technological advancement and environmental preservation.

PHOTO/COURTESY OF J. SCHMID

Lindbergh: In another time, he might have been an astronaut.

Reeve Lindbergh came to Washington in November to talk to the Women in Aerospace group about her latest book, *View from the Air*, which features breathtaking photos taken by photographer Richard Brown in 1971 and 1972 on a series of

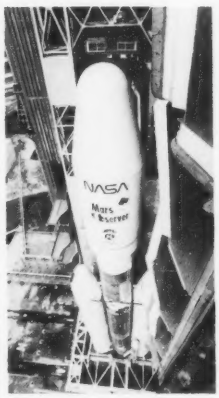
flights he took with Charles Lindbergh over rural New England. In the book, Reeve speaks for her father through her poetry, sharing his perspective on a lifetime of flying and his concern for human impact on the Earth. Asked if she thought Charles, who died in the 1970's, would have been a proponent of NASA's Mission to Planet Earth, she answered, "Yes! Yes! Yes!" She also told the audience that Lindbergh would have loved to have been an astronaut, noting that some of the statements by astronauts about preserving our Earth reflect her father's own views.

Designing Feds

What do running shoes, sunglasses, cordless vacuum cleaners, bridges, dams, highways, currency, maps and postage stamps have in common? Washington's National Building Museum opened a major exhibition in November showing how all of them are products of federal design efforts. The exhibit, entitled "From Mars to Main Street," explores how the federal government, as the nation's largest design client, is a major force in the field of design. The exhibition highlights many inventions developed during the past 25 years that owe their existence to technology initiated by the U.S. government, including the space program. The cordless vacuum cleaner and other household appliances, for example, derived technology from self-contained power tools and instruments developed by Black and Decker for the Apollo lunar landing program. Radiation blocking lenses in sunglasses were first conceived as part of a visor for astronauts. And several types of running shoes that contain a midsole for greater efficiency and reduced fatigue were spinoffs from the astronaut's lunar boot. The exhibit is on display through December 1993.

The Search Begins

On October 12, NASA began the most comprehensive search ever conducted for evidence of intelligent life elsewhere in the Universe. The search officially began with ceremonies at California's Goldstone Deep Space Network station and the National Astronomy and Ionosphere Center's Arecibo Observatory in Puerto Rico. The High Resolution Microwave Survey consists of two concurrent elements—the Targeted Search, which will use the huge, 303-meter dish at Arecibo; and the Sky Survey, which will use the 34-meter dish at Goldstone. The searches will use these and other radio telescope antennas to "listen" to stars for non-random radio noise that could suggest a signal of intelligent origin. The Targeted Search will listen to about 1,000 nearby stars similar to our Sun; the Sky Survey will survey the entire sky.



Mars Observer Heads Up and Out

Mars Observer, the first American craft to head for Mars since Viking in 1975, was launched onboard a Titan 3/Transfer Orbital Stage booster from the Cape Canaveral Air Force Station's Launch Complex 40 on September 25. The launch was nominal, but for reasons that are still unexplained, telemetry from the spacecraft's Transfer Orbital Stage (TOS) booster was not received, leaving flight controllers in a holding pattern for 40 minutes before signals from the Mars Observer were acquired by the Deep Space Network's Canberra tracking station. This was the first time any program had used the TOS.

Following the staging events, Mars Observer experienced a series of additional anomalies, including initial problems with sun acquisition and star calibration. The problems were soon resolved, however, and the spacecraft was declared healthy and on course.

When the Mars Observer arrives at its destination in August 1993, it will be placed into an elliptical orbit high over the Martian poles. The spacecraft will use its seven instruments to make a comprehensive and detailed study of the planet's atmosphere, surface and interior over the course of one full Martian year (687 Earth days). •

Honored

The Seabrook, Maryland, engineering firm of **Jackson & Tull**, has been named as Minority Contractor of the Year by NASA. The firm was nominated by Goddard Space Flight Center for having provided outstanding technical support for programs such as the Hubble Space Telescope. **B&W Services, Inc.**, Bay St. Louis, Miss., was named as Minority Subcontractor of the Year. Stennis Space Center nominated B&W for its consistently excellent support to the center for many years.

Wes Huntress

NASA acting chief of Astrophysics and Space Science **Wes Huntress** has been awarded the Korolev Medal by the Russian Federation of Astronautics and Cosmonautics for his contributions to the development of Russian-American cooperation in the exploration of the Solar System. Until recently, Huntress was the director of NASA's Solar System Exploration division. The award has been given to cosmonauts, scientists and other key individuals who have made great contributions to space research.

Astronaut John Young receives the NASA Outstanding Leadership Medal from Administrator Daniel Goldin.

The 1992 George M. Low Trophy has been awarded to **IBM Federal Systems Co.**, Houston, and **Honeywell Incorporated's Space and Strategic Systems Operation**, Clearwater. The Low Trophy for quality and excellence is awarded each year to NASA prime contractors, subcontractors and suppliers who have made significant achievements in quality and productivity improvement. IBM Federal Systems has provided support for every Shuttle flight including command, control and communications. Honeywell built the flight control systems for the Shuttle and also built both original and improved main engine controllers.

Veteran NASA astronaut and shuttle test commander **John Young** was awarded the NASA Outstanding Leadership Medal in ceremonies held in November. Young first flew in space on the first Gemini mission in 1965. He flew around the Moon during the 1969 Apollo 10 mission and landed there on the Apollo 16 flight in 1972. In 1981 Young commanded Columbia on the first Shuttle mission, and also commanded the first Spacelab flight in 1983, which was his last spaceflight. In awarding Young the medal, Administrator Goldin said of the only human to fly in space six times, "Today we're here to honor one of NASA's finest—an authentic American hero if ever there was one."

Changing Jobs

NASA Administrator Goldin has upgraded the position of Director of Small and Disadvantaged Business to an Assistant Administrator and named **Ralph Thomas** to the position. Thomas was most recently the Executive Director of the National Association of Minority Contractors. Goldin said the new office will ensure that NASA reflects the full diversity of America and that Thomas will "spearhead a determined effort to see that small and minority-owned businesses play a significant role in America's civil space and aeronautics programs."

The Office of Space Science and Applications has been split into two new units. One will focus on the Mission to Planet Earth, while the other will combine astrophysics and planetary exploration. Goldin named **Shelby Tilford** as acting head of the Mission to Planet Earth office and **Wes Huntress** as acting head of the planetary and astrophysics office. The Office of Aeronautics and Space Technology also was split into the Office of Aeronautics, with **Cecil Rosen** as acting head; and the Office of Advanced Concepts and Technology, with **Gregory Reck** as acting head.

Goldin named **Lennard Fisk**, formerly head of space science and applications, as NASA's Chief Scientist with an expanded role helping explain the importance of the agency's research to the public.

Died

Douglas Broome, Jr., deputy director of Solar System Exploration, died of liver cancer on September 27. He was 55. Broome had been instrumental in the Mars Observer program leading to its launch. He had worked previously to restructure the planetary flight programs toward a more efficient and lower cost program. Prior to his solar system job, Broome had been director of the Hubble Space Telescope program as manager of the Astrophysics Division's Great Observatories Development Branch. •

"**A** faithful friend is a strong defense; and he that hath found such an one hath found a treasure."

Ecclesiasticus 6:14

Tribute to a Friend

by Dr. John Lawrence, Office of Legislative Affairs, NASA Hq.

As a friend to NASA, Senator Jake Garn has been both a strong defense and a treasure. Our loss will be incalculable when Senator Garn does not respond to the roll call of the 103rd Congress this winter, having chosen to retire instead.

President Truman once said, "If you want a friend in Washington, buy a dog." That insight makes Garn's long-term friendship all the more extraordinary. While he has always been one of NASA's strongest supporters in Congress, his credibility was heightened by his experience as a payload specialist onboard Shuttle flight 51-D in April 1985, nine months before the Challenger accident.

In the period immediately following the accident, when the phrase "NASA bashing" entered our vernacular, a virtual army of critics second-guessed every nuance of the agency's policy and practice. Senator Garn's loyalty to NASA was unaffected. Among his colleagues on Capitol Hill, in the national media and in a variety of public settings, he stood in staunch support of NASA, without ever making excuses for the accident. Not only did he help moderate the public criticism, he also was a reassuring influence to many inside the agency who were feeling angst and profound remorse.

Like most aviation enthusiasts, Jake Garn got the bug as a child. His father, Utah's first Director of Aeronautics and a World War I pilot, often took his son with him on flights across the state. Jake already had a private pilot's license when he joined the Navy in 1956, having received it the morning of his 16th birthday. (He got his driver's license that afternoon.)

Garn won his Navy wings in 1957 and went on to fly anti-submarine patrols and shipping reconnaissance patrols along the coast of Korea and China. After his military service he joined the Utah Air National Guard, and flew in the unit's first mission into Vietnam in November 1964. He retired from the Guard as a brigadier general after 24 years of military service, having accumulated more than 10,000 hours of flying time. Ironically, as he trained for his Discovery mission, Senator Garn had more flying time than all but one member of the NASA astronaut corps.

Since his election to the Senate in 1974, Garn has worked to promote aviation and spaceflight and to assure U.S. aerospace superiority. After the Challenger accident, he was the leading advocate for the Space Shuttle program and played a key role in securing funding for a replacement orbiter. Most recently he has led the fight to maintain funding for Space Station Freedom, deflecting successive attempts to delete the program from the past two NASA appropriations bills.

Garn likes to tell the story of a laboratory director from Boston whom he met while skiing in Utah, who had lobbied against Space Station Freedom on the grounds that space research should be accomplished by unmanned or robotic systems. When the lab director lamented that he had too little time to enjoy Utah's ski trails, Garn suggested that using robots and remote control at his laboratory could free him for more time on the slopes. The director responded that such research is best done by hands-on scientists. Garn replied that the same applies to space research.

Senator Garn's flight onboard Discovery was a result of his oversight role as chairman of NASA's appropriations subcommittee. When the Democratic party regained a majority in the Senate the following year, Garn joked that NASA should, in all fairness, offer to fly the ranking minority member—which of course, now happened to be Jake Garn.

Speaking in support of NASA, Garn once said, "Nothing has lifted the human spirit higher than our exploration of new frontiers." To paraphrase his own words, nothing has lifted the NASA spirit higher than the support and encouragement of Jake Garn. •

Marshall Space Flight Center's Brad Garland can be found—off hours—at one of his many volunteer activities, especially helping teenagers prepare for their future in a technological world.

Job Opportunities

by Sonja Alexander, Hq.

As a youngster, Brad Garland knew how much it meant when an older person took an active interest in his welfare. "People volunteered for the programs in which I participated, and I found that inspirational," he recalls. Now Garland wants to give some of his own time and attention back to the young people in the small rural community of Morgan City, Alabama.

During business hours, Garland works at NASA's Marshall Space Flight Center as assistant to the director of the Institutional and Program Support Directorate, which provides technical, computer and administrative support for the center. After hours, though, chances are you'll find Garland at one of his many volunteer activities.

Most of his time is spent helping teenagers prepare for their future in a technological world. Garland is active in Marshall's Explorer Scout Post 2001 program, which began in 1990 as a result of Center Director Jack Lee's search for a program to increase the interest of local students in math and science. Garland, who was on Lee's staff at the time, says he has been able to lead the Post's development and implementation solely because he has been surrounded by a group of "extremely talented and dedicated Center volunteers."

The Explorer Post has about 100 members—girls as well as boys—who are chosen in a stiff competition from among area high school students. The members are given the opportunity to explore Marshall and NASA through a carefully structured curriculum beginning in their sophomore year. The students build rockets and payloads, work in the labs and gain valuable experience as they describe and defend their projects to the center's senior management every few months.

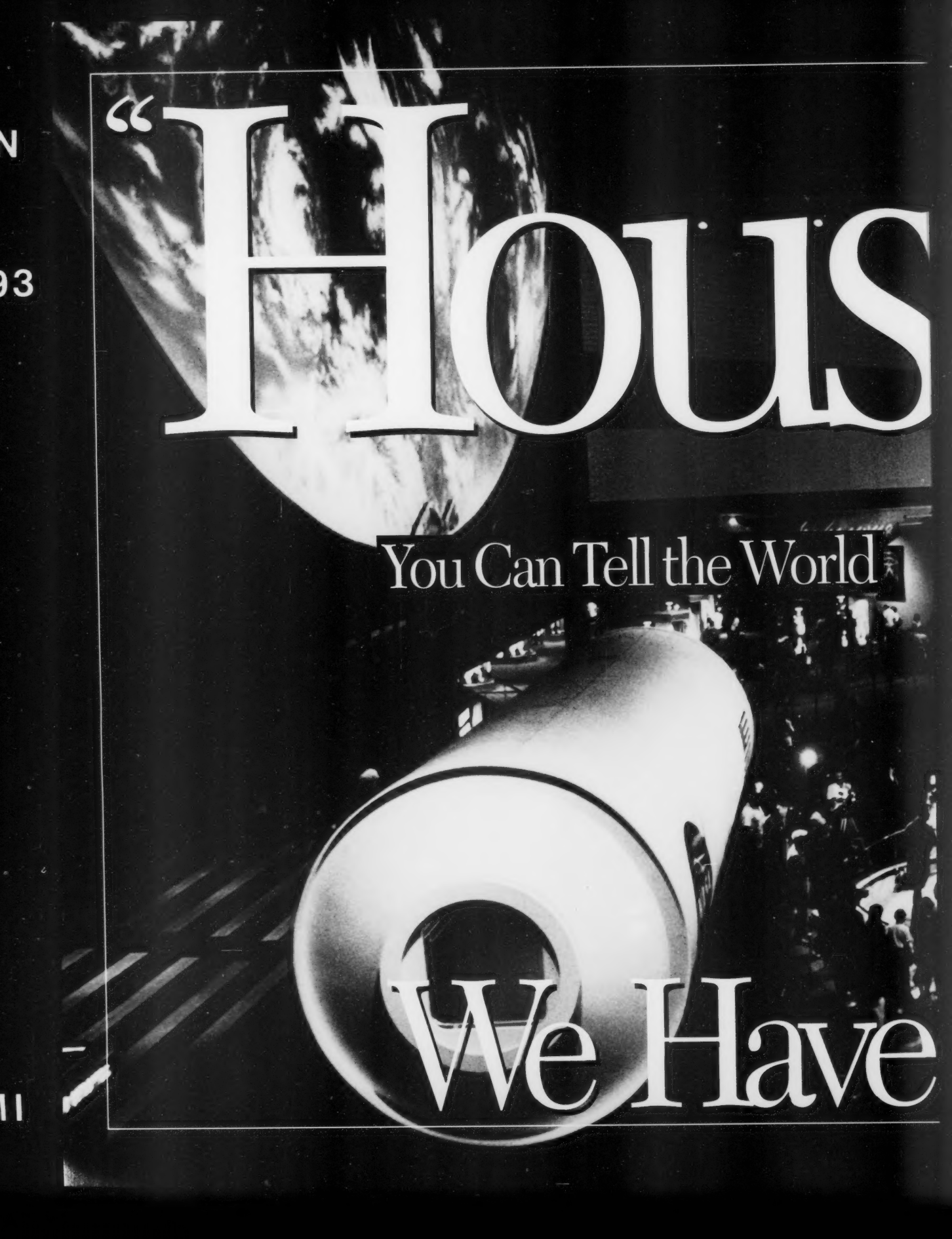
The Explorer Post keeps in touch with students even after they enter college, helping them to sharpen their skills in applied subjects such as algebra, geometry, and calculus. The students also are groomed for employment at Marshall and other science-oriented centers.

Brad Garland says that he began volunteering in his community as a Boy Scout leader when he realized how few organized activities there were for teenagers. "One day at church, someone pointed out that there were no programs for the kids to participate in." He signed up shortly thereafter and began taking his Scouts to places like the Kennedy Space Center, Washington, D.C., and Canada—trips that he thought would broaden their horizons.

He also realized the importance of providing employment for young people in the nearby community of Brindlee Mountain.

"I noted that so many of the teenagers, especially young boys, had to go outside the community to seek employment," Garland says. Rather than just bemoaning the lack of job opportunities, Garland rounded up some other Marshall employees to help him start a new business—Pizza Plus Family Fun Center. This not-for-profit corporation established in 1988, provides employment for some of the young adults in the community as well as a wholesome "hang-out." Pizza Plus also teaches the youth about handling responsibility and about some of the trials they might encounter later in life. Each of the young men and women who worked at Pizza Plus was also a member of the Explorer Post—a winning combination.

For his part, Brad Garland says he gets a lot in return for his many hours spent as a volunteer. "I have the opportunity to give back to the community, and to know that I made a difference." •


"Hous
You Can Tell the World
We Have

ton

Arrived!"

by Beth Schmid

Even if people don't know anything else about Houston, they know that it's the home of NASA's Johnson Space Center, mission control and all those gee-whiz astronauts with their awesome T-38's and simulators. It seems like visitors to JSC never can get enough of the space program. And now they can get the "closest thing to space on Earth" by visiting the new Space Center Houston, which opened in October on a 123-acre plot just west of the former visitors' entrance to JSC.

The $70 million visitors center, created and operated by the Manned Space Flight Education Foundation, is expected to draw two million visitors during its first year. Designed by Walt Disney Imagineering—the same people who designed all the attractions at Walt Disney World—and produced by BRC Imagination Arts, Space Center Houston was conceived as a celebration of our nation's accomplishments in space. The Foundation also intended it to be used by teachers as an extension of the classroom—"a big laboratory in space," as the Center's educational programs manager, Daniel La Bry, describes it.

Although the former visitors center on the grounds of JSC had been a source of pride for 27 years, the need for a more up-to-date, "hands-on" facility had long been evident. It was Hal Stall, director of Public Affairs at JSC and President of the Manned Space Flight Education Foundation, who took the necessary steps to make it a reality. Stall established the Foundation in 1986 to raise funds for a new visitors center through a capital-raising campaign and tax-exempt bond issue. The Foundation, charged with bridging the gap between the American space program and the public, did not have federal funds available for construction of the facility.

The masterminds who created the new Center have applied Johnson's standards of excellence to the entire facility, and at the same time managed to bring it all down to a personal level.

As a result of Hal Stall's dedication and the hard work of many others, visitors to Space Center Houston are now able to get much closer to living their dream of space. When you combine the Disney touch with what the Center's General Manager Vance Ablott describes as "one of the best collections of space flight artifacts in the world," it adds up to a sure-fire success.

After Disney completed its initial design phase for the Center, several key members of the Disney team were so impressed that they contracted with BRC Imagination

PHOTO/BILL INGALLS, NASA HQ

Space Center Houston's mission briefing officer, Brian Bounds, in the Mission Status Center.

PHOTO/BILL INGALLS, NASA HQ

Lifelike astronauts appear to be floating in zero-g in the Skylab trainer.

Arts so that they could stay working on the project. BRC's creative and production team decided at the outset that the Center should be a place where visitors of all ages could learn without being talked down to, could be enlightened while also being entertained, and could experience the excitement and allure of manned space flight without leaving the gravity of good old Earth.

The multi-level building has five major attraction areas that radiate like spokes from a central plaza graced by an eight-story atrium. The plaza is dominated by a video screen five stories high that provides live coverage of space activities. In addition to what they can see at Space Center Houston, a 90-minute guided tram tour takes visitors behind the real-life scenes at JSC, past the Weightless Environment Training Facility, Mission Control, the new Space Station Control Center, astronaut training areas, and the Rocket Garden.

Space Center Plaza is the place where it all starts. A full-scale mock-up of the Space Shuttle protrudes nose-first from a wall directly facing the main entrance. Inside, visitors get a close-up look at the flight deck, where they can imagine what it's like to be a Shuttle pilot. In the Shuttle mid-deck, guests get a sense of how astronauts live and work in space by seeing realistic control consoles and sleeping quarters.

The plaza also offers a variety of other enticing exhibits, plus a food court and gift shop. Don't miss the Silver Moon Cafe, a waiter-staffed restaurant that seats more than 150 people—the food and service both are out of this world!

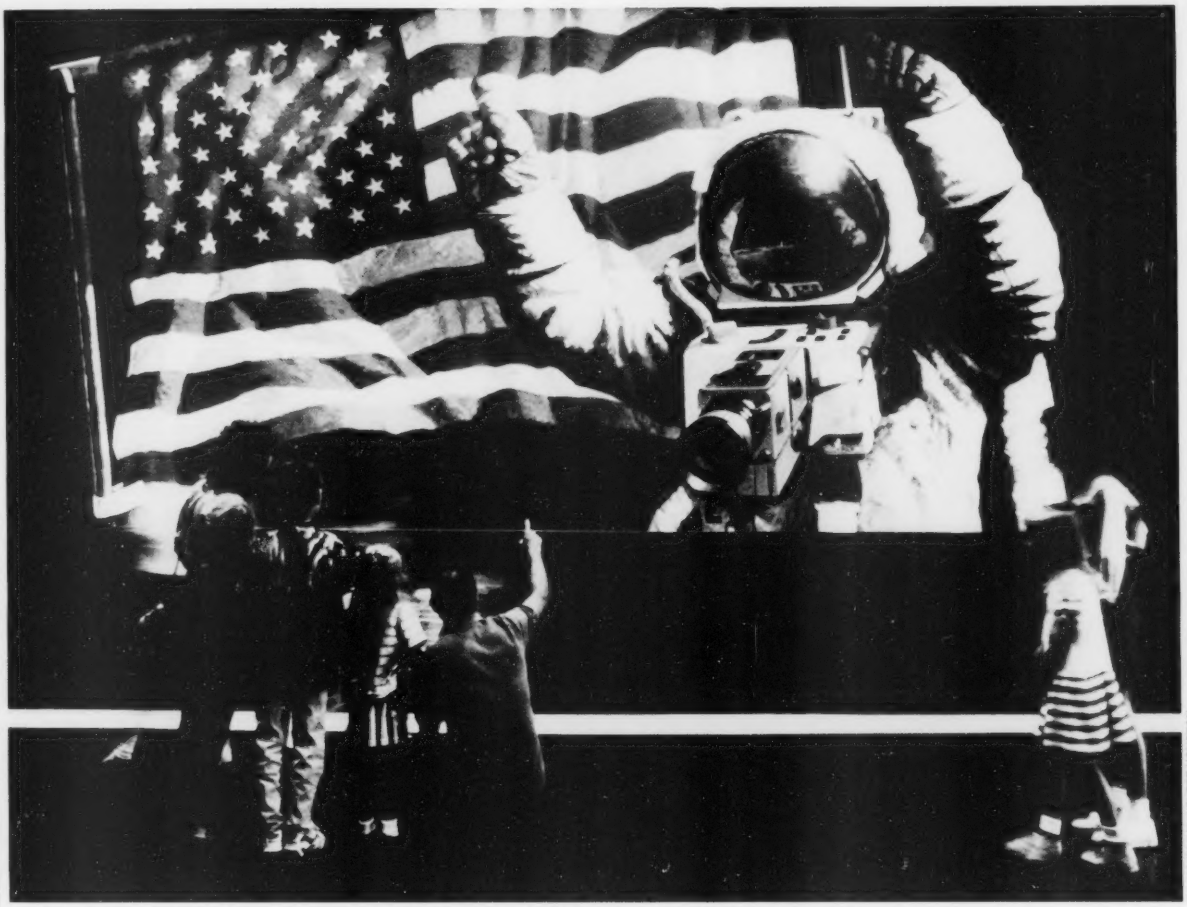
Off the main plaza is the very NASA-looking **Mission Status Center**, where briefing officers provide visitors with up-to-the-minute information about space flight activities. The presentations range from live video of astronauts in training to videotapes that preview upcoming launches.

According to Brian Bounds, one of five mission briefing officers who work in the Mission Status Center, the officers were trained to be thoroughly knowledgeable about current NASA activities. "We even spent an entire month at Johnson working with the experts," Bounds says. The officers receive faxes and phone calls from JSC throughout each day to keep them up-to-date on breaking news. During an actual Shuttle mission, the Mission Status Center even shares direct communications between JSC's Mission Control and the astronauts.

In the **Starship Gallery** next door, visitors can step into the Destiny Theater to view "On Human Destiny," a film that portrays great moments from past space missions and explains why we must continue the journey. The film was created from the 1.9 million meters of historic footage stored in NASA's archives. Its treatment of the Challenger accident and the agency's resilient recovery afterwards is particularly sensitive and skillful.

Leaving the theater, visitors enter a gallery that takes them back to the early days of space exploration. The original hardware on display includes John Glenn's Faith 7 Mercury capsule, which is set against a "starfield" of fiber-optic lighting. Also on display are the Gemini 5 spacecraft, the LEM Training Module, a Lunar Rover trainer, the Apollo 17 Command Module, the Apollo-Soyuz Docking Module and the Skylab trainer.

Ah, the Skylab trainer...the artifact around which a whole building was constructed. The trainer is as big as a three-bedroom house, so the Center literally had to be built around it. Walking through the trainer during the Center's opening reception, Skylab astronaut Alan Bean marveled at its authentic-



PHOTO/SPACE CENTER HOUSTON

Onlookers are captivated by former astronaut Alan Bean's mural entitled "America's Team...Just the Beginning," which depicts Neil Armstrong's historic first steps on the lunar surface.

ity: "I wasn't sure how they were going to get this cleaned up, but it really looks just like it did when we were training in it. Hey, there's Owen up there," he said, pointing to the very lifelike model of Skylab astronaut Owen Garriott, who appeared to be floating above the crowd in zero-g.

The Starship Gallery also houses a lunar sample vault that holds the largest collection—both in size and number—of Moon rocks on Earth. Here visitors can actually reach out and touch a lunar sample.

The **Feel of Space** is the hands-on interactive area of the Center, and on Opening Day it was all hands, with people clamoring to try a variety of space-type challenges. Twenty-four "Task Trainers" allow visitors to land the Space Shuttle or launch a satellite through computer simulation. Nearby is the "Living in Space" exhibit, a section of Space Station Freedom where visitors can assist a mission briefing officer in demonstrating how astronauts in space handle life's little routines, such as eating, going to the bathroom, showering, brushing their teeth and sleeping. The Manned Maneuvering Unit simulator, using an air-bearing floor to simulate movement in space, affords visitors the opportunity to try repairing a satellite, while experiencing the problems astronauts have in weightlessness. (This one takes lots of coordination!)

If you've ever toyed with the idea of becoming an astronaut, take a look at the movie, "To Be An Astronaut," in the Space Center Theater: You just might want to sign up on the spot. This excellent and exciting film features astronaut Charles Bolden in a scene you'd swear was a real Shuttle launch. Bolden says he was happy to participate in the project: "I really get excited about sharing my experiences in space, particularly with children. I'm excited about Space Center Houston

for its educational value."

In fact, the Center considers education to be its real mission, even though it uses entertainment as a means toward that end. "By teaching kids about space," says Vance Ablott, "we will excite them about math and science and encourage them to pursue careers in those fields." Through the Center's School Visit Program, participating schools are briefed by an educational programs specialist, who remains with the group throughout their visit to answer questions and provide assistance. The Center predicts that some 35,000 students will visit in 1992-93 as part of the visit program.

Another of the Center's educational projects involves a team of young Houston-area honor students who will take part in a NASA-led project to grow crops in simulated lunar soil. Their laboratory is a plant growth chamber that's actually part of the Starship Gallery exhibition; the students will be doing experiments while visitors walk through. Scientists conducting similar experiments for Johnson's Life Support Systems Branch will act as mentors for the student investigation.

School groups studying space-related subjects are admitted to the Center free of charge, as long as they complete registration forms ahead of time. Pre-registered schools receive packets containing a "T Minus 10" activity book, which includes a poster and an educational activity for each of the ten days leading up to their visit. The activity books were assembled by a team of professional educators, led by a 15-year science teacher whom NASA hired to coordinate the program. Three different activity books—geared toward lower elementary, upper elementary and middle school students—relate to the Center's exhibits. As Daniel La Bry says, "By using space—a natural fascination for kids—tough subject areas can seem simple."

PHOTO/SPACE CENTER HOUSTON

At Space Center Houston, everyone can take a crack at landing a Space Shuttle via computer simulator in the "Feel of Space" interactive area.

Space Center Houston is nothing short of a tribute to the people who work at the Johnson Space Center. The masterminds who created the new Center have applied Johnson's standards of excellence to the entire facility, and at the same time managed to bring it all down to a personal level. As Ablott says, "The public won't support what they don't understand. We want visitors to see how vital the space program is. The men and women behind manned space flight have done incredible things. Now we will show their achievements to the world."

When his Apollo 10 mission reached lunar orbit in 1969, astronaut Tom Stafford radioed back the message, "Houston, you can tell the world, 'We have arrived.'" Hal Stall chose these same words last October to announce the arrival of Space Center Houston. And for millions of visitors who will pass through the doors of this latest space attraction, that's good news.

PHOTO/BILL INGALLS, NASA HQ

Hands and more hands reach out to touch a Moon rock in the lunar sample laboratory.

Opening Day

It's still more than an hour before the official opening of Space Center Houston, and ten-year-old Wes See is starting to fidget. He's already been waiting outside for an hour and a half, and now he's inside, in a roped-off section of Space Center plaza, waiting for the ribbon-cutting ceremony to begin. That's the problem, though. The ropes. Being first in line doesn't mean much if you still can't *get to the stuff*.

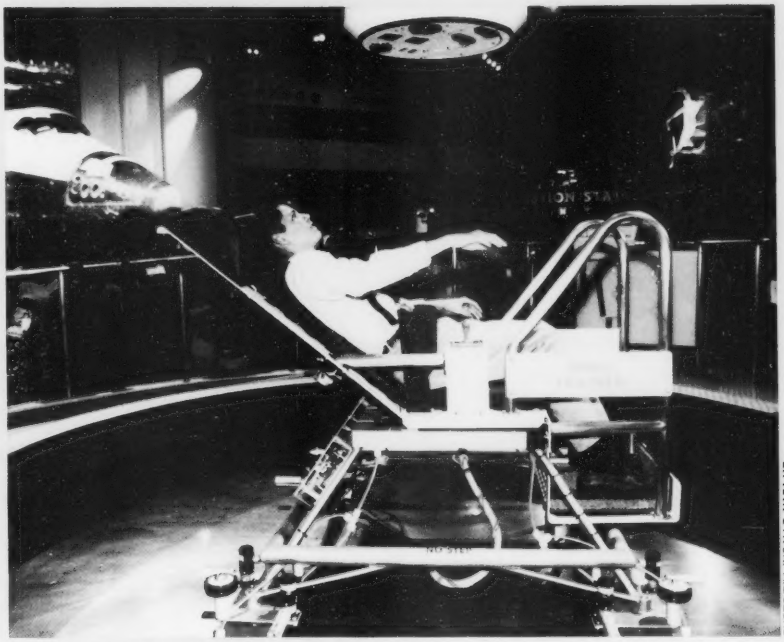
Wes tries to pay attention to all the speeches by NASA officials, and members of Congress, and even astronaut John Young, who's been to the Moon. He really does try. But this is, after all, his birthday. Not to mention a day off from school—a teacher's workshop or something. And he's first in line. And there's *all this stuff* in there.

He can see the front of Space Shuttle "Adventure" sticking out from the opposite wall, like it just landed right there in the building. Hmmmm. That'll be worth checking out. And he can hear laughing and commotion off to the left—a group of elementary school kids getting a preview of the "Living in Space" demonstration, which is being taped for a morning TV show. Lucky dogs.

Oh, well. At least Wes, his parents, and his two friends Greg and Thor are the first ones in line. Behind them are a couple of hundred other die-hards who've braved the rainy weather and forked over $8.75 for adults, $5.25 for children, to be among the very first visitors inside the world's hottest new space museum.

By eleven o'clock—the official opening time—the speeches are winding down, and Wes is fidgeting at a prodigious rate. Finally one of the attendants comes over and unhooks the rope. Wes does a brief victory dance, then runs off with Greg and Thor toward "The Feel of Space" section, with his parents trailing gamely behind.

As they sprint past the "Picture Yourself" counter, they nearly knock over the Birdsong family, who are just stepping up to have their group photo taken—the first customers of the day. Each member of the family takes turns standing against a backdrop with their arms raised in a flying pose. A computer technician then stores the video images and assembles them into a final composite photo—a fairly convincing illusion of the Birdsongs floating weightless inside Spacelab. The whole thing takes about 20 minutes—longer than expected—but this is Opening Day, and the technicians haven't quite hit their groove yet. The Birdsongs don't seem to mind, though. Dad says he'll let the kids take the picture to school, "to show that they had an educational experience."



PHOTO/BILL INGALLS, NASA HQ

Visitors to Space Center Houston can take a ride on the Manned Maneuvering Unit simulator.

Over in the "Shuttle Orientation" section, about a dozen people are busily trying out the touch-screen displays that explain anything you'd ever want to know about the Space Shuttle, from where the snacks are stored to how the reaction control system works. The highlight of this section, judging from the number of people standing around to watch, is the Shuttle landing simulator, where astronaut wannabes from the crowd get to shoot a final approach to the runway at Edwards. The "astronaut trainer" on the video screen gives lots of helpful instruction, but the landing isn't easy. Most people end up crashing, and when they do the screen goes haywire before the obviously rattled trainer staggers to his feet, saying, "Whoa! That was...different." The crowd laughs, and you can hear a woman in the back say, "This is great!"

Around the corner, another "Living in Space" demonstration is about to begin. This is the Center's only live "show," and it's an instant hit. Up on the stage, which is a faithful mock-up of Space Station Freedom's habitation module, a young woman in an astronaut flight suit is asking for volunteers. Nine-year-old Eric gets the nod, and for the next 20 minutes he becomes a model astronaut, sleeping in the sleep sack, hitting the treadmill for some exercise, using the—giggle, giggle—toilet (waste collection system to all you space types) and making dinner. From the look on their faces, the crowd is enthralled. The Disney imagineers who designed Space Center Houston have struck a perfect balance between education and entertainment—the audience is never bored, but they come away feeling like they've learned something.

Of course, no public attraction in the Video Age would be complete without at least one movie, and Space Center Houston has a spectacular one in "To Be an Astronaut." From the opening sequence—a

PHOTO/BILL INGALLS, NASA HQ

Those Moon rocks are so irresistible, and at Space Center Houston, visitors can see the largest collection on Earth.

woman astronomer learning that she's been chosen as an astronaut—the large-screen IMAX film is literally a thrill a minute. Space explorers come off as smart, talented, human, funny, adventurous—in short, anything but the bland technicians they sometimes appear to be on the evening news.

The idea that space exploration is a human adventure—something everyone can share in and appreciate—pervades Space Center Houston. The exhibits make this most technical of subjects accessible, without ever patronizing. In the Starship Gallery, which has a gigantic, glowing Moon over the entrance, visitors get to see and touch real artifacts from past space flights. The walk-through Skylab mock-up is more user-friendly than an identical exhibit at the National Air and Space Museum in Washington; somehow, you get a better feel for the size and layout of the place here than you do in the Smithsonian. You can even imagine yourself living here.

The future is represented, too. A lunar exploration exhibit features a wall-sized blackboard explaining how and why we would return to the Moon. An equation is written in chalk: MOON = construction materials + energy resources + life support + knowledge.

In a brightly lit lunar sample laboratory, visitors can touch one of the most precious objects on Earth—a piece of the Moon brought back by the Apollo astronauts. Even if they've seen Moon rocks before, very few people have actually touched one, and they line up almost reverently.

"I never dreamed it would be so smooth," says a young boy, coming back for seconds. "It feels like silicone," says an older woman in a hushed voice. Hard to believe a little stone could provoke such feelings of awe.

By this point in the tour, even the most hard-hearted cynic is filled with the buoyant spirit of space exploration, and video "messages" taped by JSC employees testifying to their faith in the future only add to the swell. What could possibly top all this?

How about the real thing? Every few minutes, a tram picks up a new load of passengers from a waiting area outside the visitor's center to take them on a tour of Johnson. At a few carefully chosen stops, visitors get off the tram to see *real* NASA people doing *real* NASA work. On a lucky day, they might get to watch astronauts training to use the Shuttle's Remote Manipulator System arm, or practicing spacewalks underwater in the Weightless Environment Training Facility. Flight-suited, Disney-friendly tour guides keep up a running commentary as visitors view mock-ups of the Shuttle, Spacelab and Space Station Freedom from glassed-in walkways. Then it's back in the tram, past the humongous Saturn V and other historic launch vehicles in JSC's "Rocket Garden" before returning to the visitor's center.

On the way back, the tour guide gets in a few messages about the importance of the space program, how it costs less than one penny of your tax dollar, and how it returns all kinds of technology and value to the American economy. That may be well and true, but this crowd doesn't need any more convincing that space exploration is worth it.

Ask Wes See, just turned ten years old today, who's now in the endgame of his strategically planned whirlwind tour of Space Center Houston. Having just scarfed down a hamburger and star-shaped french fries at the food court, Wes races toward the last unconquered peak—a ride on the Manned Maneuvering Unit simulator. His father is dragging. Mom's nowhere in sight. Even Greg and Thor are strangely subdued, even pensive, after seven hours. Not Wes. He's desperately trying to get picked as the next volunteer, and is waving one arm frantically over his head, with the other propped beneath his underarm for added extension. His argument is direct, simple, elegant: "ME!! Take ME!!"

The place is closing soon, and it's starting to occur to Wes's Dad that they may never make it out of here. He winces as another volunteer, not Wes, climbs into the chair that whooshes around an air-bearing floor, simulating an astronaut chasing an errant satellite. Despite his rising panic, the father says that they're all happy they came. It's really been great.

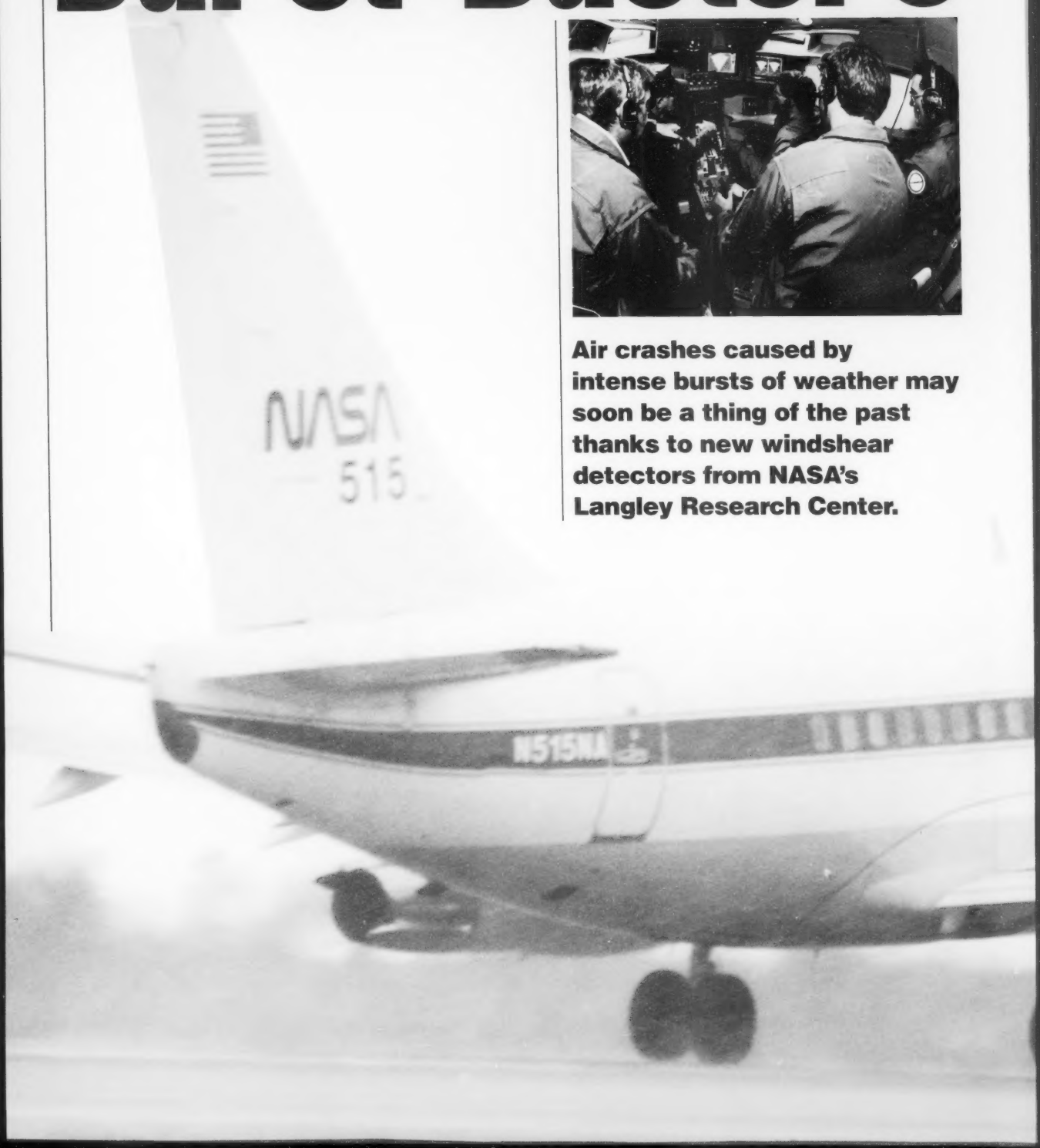
I say goodbye and good luck—I have a plane to catch—and take one last look over my shoulder at Wes, defiant and unflagging, arm higher than ever, determined to bag that one last activity. If he doesn't, it wouldn't surprise me at all if he came back tomorrow. •

—Tony Reichhardt

by Michael Finneran

Burst-Busters

Air crashes caused by intense bursts of weather may soon be a thing of the past thanks to new windshear detectors from NASA's Langley Research Center.



The thunderhead lay directly ahead of the 737 jet, a mountain of black pounding down a steady stream of rain and wind. Lightning flashed and the plane's windows blinked like static-stricken TV screens. Storm cells like this can knock a plane to the ground, but instead of veering away, the jet shot straight toward it. The cabin went dark and rain lashed the windows as the plane bounded through the heart of a white-knuckle flyer's worst nightmare. Half a minute later it slipped out, then banked sharply for another stab at the storm.

"Looks like a good one," a voice crackled over the intercom.

For the crew of the Langley Research Center's "flying laboratory," the encounter 274 meters above Orlando, Florida, last August was just what they wanted: a one-on-one with a sometimes deadly weather condition known as a microburst windshear. The payoff: a chance to test sensors designed to warn pilots of what's ahead so they can prepare to ride it out or steer clear.

The Langley windshear team has spent the last six years developing a soon-to-be-available technology that will allow pilots to fight one of the major causes of airliner crashes during takeoff and landing.

"Windshear microbursts can be extremely intense, and they can be lethal," says Roland Bowles, manager of Langley's windshear program office.

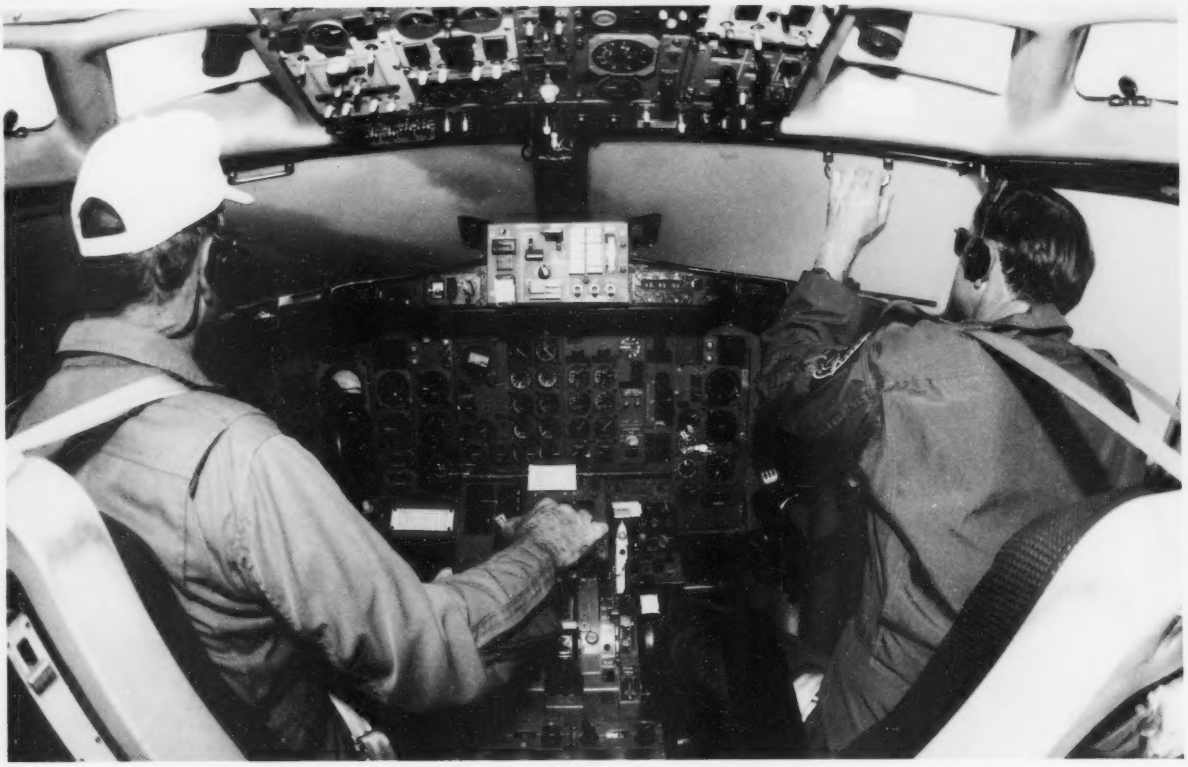
The aviation industry considers them to be a major safety issue. Windshear was a factor in 27 aircraft accidents that accounted for more than 500 deaths and 200 injuries between 1964 and 1985. Between 1975 and 1985, windshear figured in about half of all crashes.

Several major accidents in that same decade led to the recognition of windshear as a major hazard. In 1975, an Eastern Boeing 727 crashed at the Dallas-Forth Worth airport, killing 113 people. Another 727 crashed in New Orleans in 1982, killing 124 passengers onboard the Pan Am flight. Then, in 1985, 145 passengers were killed when a Delta L-1011 went down at JFK Airport in New York.

Bowles and his crew, which has flown through more than 50 microbursts, hope to make those kinds of crashes a thing of the past. "This is going to save lives," he says. "If you and your family are flying on a commercial airliner after 1995, there will be windshear detection technology aboard as a result of this NASA program."

The $20 million-plus program began with a NASA/Federal Aviation Administration (FAA) agreement signed in 1986 at the urging of Congress, the National Transportation Safety Board and the National Research Council. Under a 1988 FAA directive, so-called "reactive" windshear detection devices are to be installed on airplanes by the end of 1993.

As Langley's 737 takes off from Orlando International Airport, scientists in the windowless research cockpit watch out for microburst windshears.



Pilots Dick Yenni (left) and Mike Phillips guide the "flying laboratory" into bad weather over Orlando.

But reactive systems can't detect a microburst until a plane already has entered it—which may be too late to prevent a crash. The sensors Langley is developing will detect microbursts 20 to 40 seconds in advance, giving pilots time to react.

"NASA studies have shown that every second of advance warning pays big dividends in terms of survivability," Bowles says. "It's the old adage—an ounce of prevention is worth a pound of cure."

Airlines that elect to use an advance-warning system must install them by December 1995, according to the FAA directive.

"We have to be able to develop systems that pilots will have high confidence in," Bowles says. "That really frames the technological challenge for us. The key is to put the information at the pilot's fingertips, so he can believe in it and it becomes part of the routine."

As part of the program's final test phase, Langley's 737 flew three sensors—a laser, a microwave radar and an infrared radiometer (see box)—on a total of four deployment missions in 1991 and 1992. The two- to three-week trips were split between airports in Denver and Orlando, and took place in the summer, when storms are most likely to happen.

Not all thunderstorms conceal dangerous microbursts. But those that do can generate winds of more than 80 miles an hour. And the shifting direction of those winds is just as treacherous as their speed. As a microburst pours from a cloud, it hits the ground and spreads out like an upside-down mushroom, producing first a headwind, then a downdraft, and finally a tailwind for any plane passing through it.

These swift wind changes can be fatal during takeoff or landing, when a plane's speed is low and there's little room—or time—to maneuver. As the plane encounters the headwind, it is lifted up. The pilot, not knowing that the wind is about to change, stays on the flight path by cutting power and dropping the nose. But when the wind shifts suddenly to a tailwind, it combines with the power reduction to force the plane down.

It can be risky business flying into such weather, so on the test flights, Langley's 737 took few chances. The plane was even flown back to its home base in Virginia when Hurricane Andrew smashed across South Florida last August (it returned to continue its mission after

the threat had passed).

"It sounds dangerous, but really it's well orchestrated," says Dick Yenni, safety captain aboard the 737. "If we decide it doesn't look good, we don't go into it. We just don't take unnecessary risks."

If sensors showed the microburst exceeded a predetermined hazard level, the pilots steered away. And to ensure a safety margin, the plane never entered a microburst when flying lower than 228 meters above the ground or slower than 386 kilometers per hour. Most windshear-related crashes have occurred because aircraft were flying too "low and slow" to escape the microbursts.

The Langley team spent long hours each day during these "deployments." Along with pilots and managers, the crew included technicians, contractors involved in developing the sensors, and engineers and scientists from four Langley directorates—more than 50 people altogether.

"This is going to save lives," says Bowles. "If you and your family are flying on a commercial airliner after 1995, there will be windshear detection technology aboard as a result of this NASA program."

"This was a very complex operation," says Bowles. "It was amazing that we could take this many people, move them and the aircraft around the country, and make it work."

Each morning crew members left their hotel rooms and drove to the airport, where the 737 waited on the runway apron outside the charter operation where it was based. The wait for bad—or in this case, good—weather began in earnest after a midday briefing. When word came to fly everyone scrambled into the plane, off in search of another encounter.

The weather alerts came from a ground-based system operated by the Massachusetts Institute of Technology's Lincoln Laboratory, called the Terminal Doppler Weather Radar (TDWR). The experimental radar can detect and measure the strength of microbursts around an airport. In fact, the presence of TDWR at the Orlando and Denver airports was a main reason Langley managers chose those sites for the flight tests.

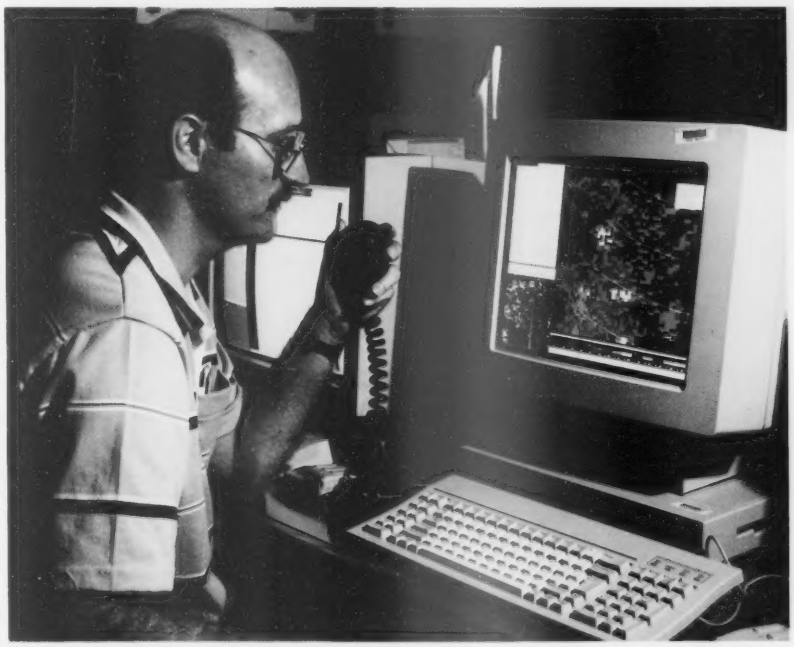
More than 40 TDWRs are to be installed at airports around the country by mid-1994. But while the ground-based system will be an important aid for searching out microbursts, advance-warning sensors still are needed, Bowles says. For one thing, not every airport will get a TDWR. For another, onboard sensors will give a flying plane a view of what's ahead, something a ground-based radar can't do.

"The aircraft needs to be like the turtle and its shell: You carry your protection with you," says Bowles. "Wherever you go, it's always there."

Langley's 737 resembles a commercial airliner only in shape and size. The 25-year-old plane—the first 737 made by Boeing—has been extensively refitted since Langley bought it in 1974. The craft's most striking feature is a second cockpit for research where the first-class seats would have been.

"The airplane is flown, for the most part, from the research cockpit," says Michael Lewis, deputy manager of Langley's windshear program.

The rear of the jet is crammed



Fred Proctor of Langley's Flight Management Division communicates with the 737 from the Doppler radar installation at Orlando's airport.

with data-collection instruments, many of which are permanently part of the plane, which has been used for numerous experiments apart from the windshear program.

During the flights over Denver and Orlando, the 737's advance-warning sensors worked in tandem with the TDWR to locate and prepare to fly into microbursts. Chatter from five intercom and radio channels came over the headsets as the plane snaked through the sky in a 48 kilometer radius around the airport. In the research cockpit, crew members monitored their displays as the plane maneuvered toward microbursts, which were depicted as color-coded ovals with numbers indicating predicted hazard levels.

The cabin went dark and rain lashed the windows as the plane bounded through the heart of a white-knuckle flyer's worst nightmare.

The idea was to detect the deadly downdrafts using the advance warning sensors, then fly through them while reactive sensors took an actual reading. The measure of how well the advance warning sensors worked was how closely their readings matched the data from the reactive instruments.

"The Doppler sensors generally worked extremely well," says Lewis. "What we were seeing was, in most cases, what we actually got."

Some 30 people were seated amid all the onboard electronic wizardry every time the "flying laboratory" took off. But the action wasn't limited to the sky. On the ground, a Langley radar van also collected data and monitored the weather. Nearby, other Langley personnel gathered more data and tracked the plane on a monitor during its one- to three-hour flight. And the work didn't stop when the plane touched down. After a post-flight briefing, many of the researchers and technicians stayed behind to tweak systems, work data and prepare the aircraft for its next flight.

Bowles says the next step is to analyze the wealth of information gathered during two years of flight tests and make it available to the FAA and industry.

"We have collected very good data that will have lasting scientific value long after this program is finished," he says. "But our job is not to package this technology or to impose it on the industry. Our major role is to provide the industry with information so they can come up with the sensors that can be installed on aircraft."

And when that happens, he adds, we will put the problem of windshear-related accidents behind us. •

Researchers monitor an impressive suite of data-gathering electronics on each test flight.

Langley is developing three types of forward-looking systems for windshear detection:

A laser-based system, called Doppler LIDARS (Light Detecting and Ranging) measures the speed of aerosols—minute particles in the air such as dust—to indicate changes in the wind. It works best for microbursts with little moisture in them. Langley flight-tested this system, which is mounted on the belly of the 737, for the first time last summer.

Another system in the nose of the aircraft uses microwave radar to locate microbursts by measuring sudden, large changes in the speed of raindrops in storm cells ahead of the plane. This system works best for "wet" microbursts accompanied by rain.

Another system mounted on the side of the plane uses an infrared light sensor, that detects microbursts by measuring air temperature differences ahead of the aircraft. Typically, a microburst is characterized by a cooler column of air.

Michael Finneran is the editor of the Langley Research Center's newspaper, the Researcher News. *Photos courtesy of Peggy Pancoast, LaRC.*

With the help of NASA materials research—and a few leftover parts from a Space Shuttle payload at the Marshall Space Flight Center—wheelchair racer Doug Kennedy is off and winning.

On Your Mark, Get Set....

by Robert Lessels

A few years ago, Douglas Kennedy, a healthy young man from Haleyville, Alabama, fell from the bed of a truck, leaving him paralyzed below his rib cage. Since that time Kennedy has become one of the nation's premier wheelchair racers, laying claim to many world records and a gold medal from the 1990 Goodwill Games in Seattle.

Kennedy's involvement with NASA started when the Easter Seals Association asked the Marshall Space Flight Center if it could develop a wheelchair suspension system to cushion riders, particularly those who suffered from osteoporosis, from rough surfaces. William Snoddy, Marshall's Deputy Director of Program Development, suggested that the center's Technology Utilization Office contact Doug Kennedy to get a wheelchair user's perspective on the subject, and Kennedy agreed.

During one of his first visits to Marshall, Kennedy was given a tour of the center's facilities, including the new Productivity Enhancement Complex. There he learned of work underway to find new applications for composite materials. When he heard that epoxy resin/graphite compounds were, pound for pound, stiffer and stronger than steel, he asked if they might be used to build the frame for a racing chair. John Cranston, a Martin-Marietta contractor working for Marshall and an expert in making human-powered racing vehicles from composite materials, said they could, adding that lightweight titanium also could be used to replace the heavy steel portions of Kennedy's wheelchair.

Cranston enlisted the help of several members of the lightweight, human-powered vehicles design team to create a structurally enhanced racing chair for Kennedy. As the design developed, engineers John Vickers and William McMahon were among the many people at Marshall who added their talents to the project.

Using materials left over from a Space Shuttle payload developed at the Productivity Enhancement Complex, the team was able to fabricate a "T"-frame racing chair using epoxy resin/graphite and titanium. The new chair is four times stiffer than Kennedy's old aluminum design—a key factor in improving racing performance. When Kennedy thrusts his aluminum chair forward, the frame actually bends as much as a quarter of an inch. Not so with the new "T"-frame, whose stiffness should give Kennedy and other wheelchair racers a significant competitive edge.

The proof came at the Doug Kennedy Rotary 1500 meter race in Haleyville last July, where Kennedy finished fourth but knocked 10 seconds off his best track time on the course using the new chair.

Events such as this give physically challenged athletes from around the world a chance to demonstrate their ability to cope with physical limitations. But the work being done at Marshall benefits more than just racers like Doug Kennedy. A light wheelchair made of composite materials and titanium would be of great benefit to anyone whose age or infirmities make it difficult for them to manage a heavier chair. In addition, the materials could be used to improve a wide range of medical devices: walkers, braces, splints and stretchers—even canes—and could make coping with advancing years or physical disabilities that much easier for millions here and abroad.

Meanwhile, for Doug Kennedy and other wheelchair racers like him, a little bit of space technology can go a long way toward adding to their self-confidence and sense of accomplishment, and maybe even shaving off a few seconds in a close race. •

Robert Lessels is a technical writer in the Technology Utilization Office at the Marshall Space Flight Center.

JPL engineer Stephen Petilli says Wilck's method of teaching works so well because all completed projects are subjected to stringent, objective testing.

Some people learn to swim when some older, wiser person, usually without much warning, throws them in the water. For a group of young engineers at the Jet Propulsion Laboratory, learning to build complex digital processors is much the same kind of experience.

Engineers in JPL's Digital Projects Group don't produce standard, ho-hum computers. They produce Rolls-Royces: the best, fastest, most reliable digital data processing systems that NASA's money can buy. Supervising this hardware hatchery is Helmut Wilck, a soft-spoken engineer who came to JPL in 1966 with a master's degree in computer science from the University of Southern California. For the past decade or so, Wilck has been breaking in new engineers using his own version of the sink-or-swim method.

Helmut Wilck breaks in rookie engineers the old-fashioned way. If the design works, you pass. If it doesn't, you go back to the drawing board.

And by most accounts, he's been very successful.

The young engineers in the Digital Projects Group design and build cutting-edge signal processing systems for a wide range of NASA projects. The group's handiwork

How to Build an Engineer

by Linda Billings

includes processors for the Magellan Venus mission, a synthetic aperture radar (SAR) receiving station in Alaska, and the recently inaugurated High Resolution Microwave Survey (HRMS), which began combing the radio skies as part of NASA's search for extraterrestrial intelligence on October 12.

Wilck's protégés include the best and brightest graduates of some of the nation's top engineering breeding grounds—the likes of Cal Tech, Stanford and Rensselaer. Eight of the 12 people currently in his group are under 30. With Wilck as their mentor, the young engineers get direct experience with "womb-to-tomb" technology development—seeing a project through from start to finish—early in their careers.

In the late 1980s Wilck's team developed the Advanced Digital SAR Processor (ADSP), a super microcomputer for synthetic radar data analysis. After that came the Magellan ground radar processor (actually an upgraded ADSP), followed by the SAR processor in Alaska. Now the team is working on an upgrade to the two-million-channel spectrum analyzer they built for the prototype SETI survey that began in October, which will be used for the full HRMS Sky Survey.

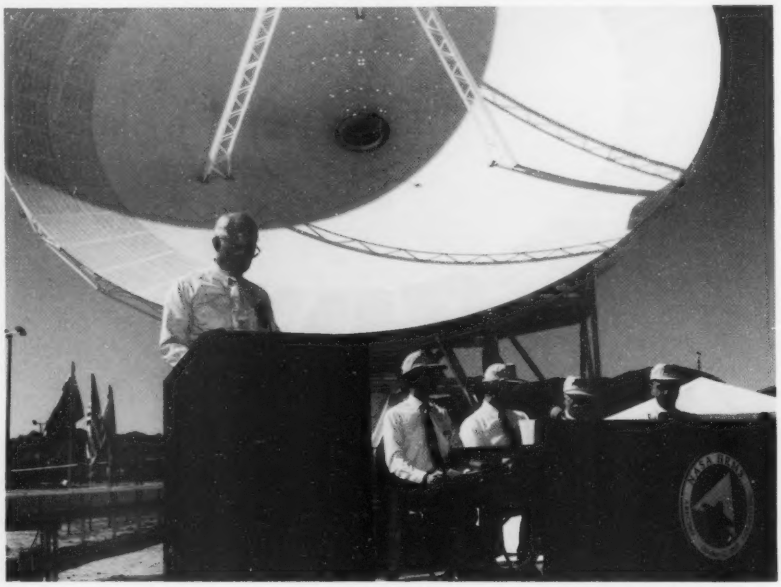
This kind of commonality and overlap between projects is a hallmark of Wilck's group. The young engineers swap hardware, ideas, information and expertise, switching from one project to another and always backing each other up.

One benefit of all this knowledge-sharing is that it keeps down costs and development times. But even more important is the human benefit: Wilck's "rookies" end up with skills and experience that most private sector engineers take years to acquire. Starting from scratch, they learn to design a system, find and buy parts, run computer simulations and tests, help develop the software, and finally turn on a completed system.

Ben Charny, who spent eight years with Wilck's group, was lead design engineer on the ADSP project and task leader for the Alaska SAR processor. Charny earned his master's degree in applied physics in his native Russia, then came to the United States and worked for two years at a company that made aircraft brake controls. After earning another master's in electrical engineering from Stanford, he came to JPL in 1983.

Charny says he got a lot of offers, but Wilck's was the most interesting. Charny wanted to get in on the start of a project, not in the middle. So Wilck immediately put him to work on the design of the ADSP. His next assignment was to upgrade that processor for Magellan. The resulting system, which took three years to design, has since generated a wealth of spectacular radar images of the surface of Venus.

Charny also was project engineer



When the High Resolution Microwave Survey (HRMS) began on October 12, the Digital Projects Group's processor was "on board." Shown speaking before the 34-meter radio telescope is Dr. Gary Coulter, HRMS program manager at Headquarters. Seated left to right are JPL Director, Dr. Edward Stone; JPL's Dr. Michael Klein; project scientist, Dr. Samuel Gulkis, and Cornell University scientist, Dr. Carl Sagan.

for the Alaska SAR processor, which processes data downlinked from the European ERS-1 and Japanese JERS-1 remote sensing satellites. On the Alaska project, he says, "we did everything," from hardware and software design to installation at the University of Alaska in Fairbanks.

One of the secrets of Wilck's success, says Charny, is that he pays close attention when interviewing prospective employees, looking for enthusiasm, a willingness to learn and a knack for teamwork. Ted Robnett is a case in point. After graduating from Berkeley with a bachelor's in engineering physics in 1986, Robnett was anxious to start work right away. The trouble was, his degree was a bit unusual, and recruiters kept tossing him into the "other" category.

But Wilck saw his potential, and offered him a job working with Ben Charny's team on the Alaska SAR processor. With only one digital design and one programming course under his belt, Robnett plunged right into his new job, spending the next couple of years building printed circuit boards.

"My first year I must have worked on average of 50 or 60 hours a week...because I liked it," he says. "I wanted to show that given a chance, I could do well." Along the way, he found time to earn his master's in electrical engineering—via JPL's grad-school-by-television program—from the University of Southern California.

Robnett says that he had chosen engineering in school because it had guaranteed a job. But in Wilck's group he found that he was good at it, too—so good, in fact, that he got bored after a few years.

"I wasn't tired of engineering, but I wanted more than that." So he turned to medical school. What doctors and engineers have in common, he explains, is that they are both diagnosticians. Now Robnett is in his first year of studying medicine at Yale. But he still thinks of his boss at JPL with admiration. "In my opinion," he says, "Helmut was, and is, a great engineer."

One of Wilck's current crop of whiz kids is George Zimmerman, the senior engineer in the group's digital section. When asked his age, Zimmerman responds, "I'm ancient." Translation: He's 29.

"I majored in electrical engineering because it was kind of fun," he says. "I always liked to build things." After receiving his bachelor's from Stanford in 1985, he, too, thought about medical school. But after working in the private sector in his senior year, he decided he liked engineering enough to stick with it.

Some managers hire good people and then try to find enough work to keep them occupied. "Helmut hires people when he has something for them to do," says Zimmerman.

At first Wilck set him to work on the ADSP project, but eventually, when that was nearing completion, had to face the problem of, "What am I going to do with George?" Wilck took note of Zimmerman's flair for systems engineering and named him the HRMS Sky Survey systems engineer, effective a week after he was awarded his Ph.D. from Cal Tech in 1990.

Wilck likes to hook up his young engineers with "really good people...very senior guys with a lot of experience," says Zimmerman. One of those "senior guys" is Barney Oliver, a brilliant, sometimes crusty engineer who came to work for NASA after retiring from an illustrious career at Hewlett Packard.

Zimmerman tells of going head to head with Oliver, who can be a formidable opponent, over a design problem with the prototype spectrum analyzer for HRMS.

"He kind of got under my skin," says Zimmerman. But in the end, Oliver guided the JPL engineers to a solution, and everyone ended up happy.

Helmut Wilck gets satisfaction out of developing systems that actually get used.

Patricia Jennex spent six years in Wilck's group, starting out part-time while completing her undergraduate engineering degree at California State University in Northridge. Now she works in JPL's radar section. But the training and high standards she learned from Helmut Wilck have equipped her to take on jobs that might have seemed too daunting otherwise.

Another member of the group, Steve Petilli, says that his first assignment for Wilck—working on a filter for the HRMS prototype spectrum analyzer—was a big step beyond what he'd done in college. The circuit boards in school typically had 5 to 10 circuits; this filter was made of about 15 individual boards, incorporating up to 500 integrated circuits apiece.

Stephen Petilli and Valerie Stanton, two of the engineers that Helmut "built."

"I almost dreaded coming in to work for the first couple of months I was here, because the work was so challenging," Petilli recalls. He had no meetings to attend, no other tasks to work on, nothing else to do but design his board, plugging away at the same problem day after day. By the time he finished, though, he realized how much he'd learned and how much confidence he had gained. Now he's designing a processing chip for the operational HRMS Sky Survey, which will be developed over the next several years.

Petilli says the reason Wilck's method of teaching works so well is that he subjects all completed projects to stringent, objective testing. If the circuit board tests out, you're done. If it doesn't, you go back to the drawing board.

"Helmut has complete faith and confidence in the ability of all the engineers in his group," Petilli says, because they've all passed the "board" test. "It's a very effective system of determining whether a brand-new engineer has 'the right stuff.'" After that, Wilck doesn't involve himself in the technical details. He lets his engineers know exactly what they're supposed to be doing and never micro-manages.

George Morris, manager of JPL's Ground Antennas and Facilities Engineering Section, has known Wilck for 15 years and has collaborated with him on jobs in the past. He says Wilck's engineering philosophy includes a few basic principles, like "building quality in" from the beginning, extensive product testing, and modularity. A good example of the result of this philosophy is the Magellan data processor, which, says Morris, is "beyond the state of the art....There isn't anything in the open literature [like] the machines that Helmut's group builds."

Wilck's manager, Joseph Yuen, notes that Wilck is only one of several group supervisors in his section who apply the sink-or-swim approach to staff development. But Wilck has been doing it longer than anyone else, and he's very good at it. Project after project, says Yuen, "Helmut has been in budget and on time."

All the projects completed by Wilck's engineers have been successful—maybe not 100 percent successful, Yuen notes, but that's because they're all high-risk initiatives. Lowering expectations might have ensured 100 percent success, he says, but "we really set challenging goals."

As for Wilck himself, he says, "I get a lot of enjoyment out of developing systems that actually get used." And at the same time, "I get a great deal of satisfaction out of working with young engineers, helping them to get their careers started in the right way." •

Linda Billings, a senior writer for BDM International, wrote about the Small Explorer program in the Fall 1992 issue of the magazine.

FANCY

How does a space garden grow? With red LEDs and thin blue lights, and plenty of TLC.

The day when astronauts will have to grow their own food in space may still be many years away, but a pair of scientists from NASA's Kennedy Space Center and Walt Disney World's EPCOT Center are already mixing soil and planting crops in preparation for humankind's long-distance voyages of the future. Their goal is to see that the larder stays well stocked when astronauts leave Earth orbit for the Moon, Mars and beyond.

Chris Brown, a plant physiologist with the Bionetics Corporation working at KSC, and Andrew Schuerger, a plant pathologist based at the Land pavilion at EPCOT, joined forces just over a year ago. Since then, they've been experimenting with lighting and various types of growing environments in a laboratory near the Land pavilion, studying not only the development of plants but also new ways to grow them.

Apart from the sponsors of the research—NASA and Disney aren't normally associated with farming—the most unusual aspect of the project is the artificial lighting used to nourish and stimulate the plants. Rather than relying exclusively on tried-and-true fluorescent or high-pressure sodium lights, Brown and Schuerger are experimenting with light-emitting diodes (LEDs), virtually identical to the ones that illuminate digital clocks and watches, to provide artificial "sunshine." Even the colors are different in this otherworldly garden: the LEDs are red and the lights are blue.

"Sodium or fluorescent lights work great in indoor laboratories here on Earth, but we're going to have some substantially different circumstances once we start growing plants in space," says Brown. "The presence of humans and a less than ideal environment provide us with some unique challenges."

Lighting is a major challenge. Typical glass greenhouse lights were ruled out for a number of reasons: they have short lifespans and poor energy efficiency, they're too fragile, and they put out too much heat—all drawbacks in the limited confines of Space Station Freedom or a ship bound for Mars.

Chris Brown (top) and Andrew Schuerger tend pepper plants in their "garden" at EPCOT.

The idea of using LEDs as an artificial light source for plants is not a new one. Developed and marketed by Quantum Devices, Inc. of Barneveld, Wisconsin, the growth-spurring LEDs were first checked out by scientists at NASA's Ames Research Center. Since then they've undergone more studies by a handful of researchers at various universities and private institutions, but none are believed to be as extensive or fruitful as those conducted by Brown and Schuerger.

Although it has much of the same paraphernalia found in any other indoor plant facility, there's something about Brown and Schuerger's garden that makes it look more like the set for a science fiction movie. The bright, hot lights used in most plant factories are gone. Instead there are warm,

by Mitch Varnes

PLANTS

fingernail-sized red LEDs and pencil-thin blue bulbs positioned only inches above rows of pepper plants. Velcro-bound covers shroud the plants, but the surreal red light still manages to spill through the seams of the small growing areas into the lab's open spaces.

"Plants only need to receive certain types of color," explains Schuerger, "and common broad-spectrum lights give us much more energy and heat than what [the plants] really need or use."

The advantage of LEDs is that they give off very little heat, and they radiate in a narrow band of light. Schuerger says that the scientists have found red wavelengths to be very effective in promoting photosynthesis and plant growth. Judging from the healthy color and broad leaves of their pepper plants, he and Brown obviously are on the right track. The plants spend the first three weeks of their growth cycle under common white lights, then switch to red LEDs and blue lights on the 22nd day.

Judging from the healthy color and broad leaves of their pepper plants, Brown and Schuerger obviously are on the right track.

"The transition of the pepper plants from the white lights to red LEDs is fairly smooth and almost undetectable," says Brown. "The plants respond well enough to them, but we really start seeing some good reactions when we intersperse blue lights among the red ones."

Not only do the blue lights and red LEDs stimulate healthy pepper plants, they also have positive effects on diseased crops, helping to restore them to good health.

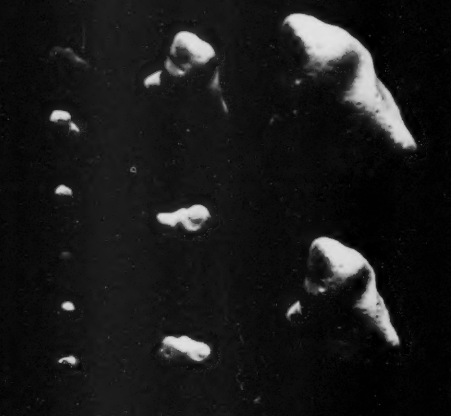
"No matter how hard you might try, it's almost impossible to grow an entirely disease-free crop," says Schuerger. "Integrated Pest Management (IPM) is a continuous effort here on Earth, and we can only assume that pests will likely be a problem for plants in space. One of our objectives is to make sure we've looked at every possible scenario so that we're not too surprised when we begin growing plants in space."

The LEDs are being tested for their usefulness in future Mars ships, but spinoffs of Brown and Schuerger's research are likely to find their way into the marketplace here on Earth much sooner. The miniature LEDs—which can generate up to half the light intensity of full sunlight—may have uses in commercial gardening, pest management and other areas yet to be imagined.

"The technology is still early in the development, but I think LEDs could have far-reaching applications," says Brown.

"We're delving into a new area of plant research here," says Schuerger, adding that this is an example of EPCOT's dedication to future-oriented science. "It may be a while before the results of our studies fly in space or before their spinoffs are in your local garden shop, but we're confident that those days will come." •

Mitch Varnes is a public affairs officer at the Kennedy Space Center. His story on the Space Shuttle ice team appeared in our Fall 1992 issue.



1992 The Year in Air and Space

(Top photo) A new computerized Performance Seeking Control system—which automatically adjusts fuel and air flow in an F-15 jet to achieve the most thrust with the least amount of work by the engine—was demonstrated at supersonic speeds for the first time in 1992. The ongoing research should lead to greater aircraft efficiency and longer engine lifetimes, and may make future supersonic commercial flights more economical.

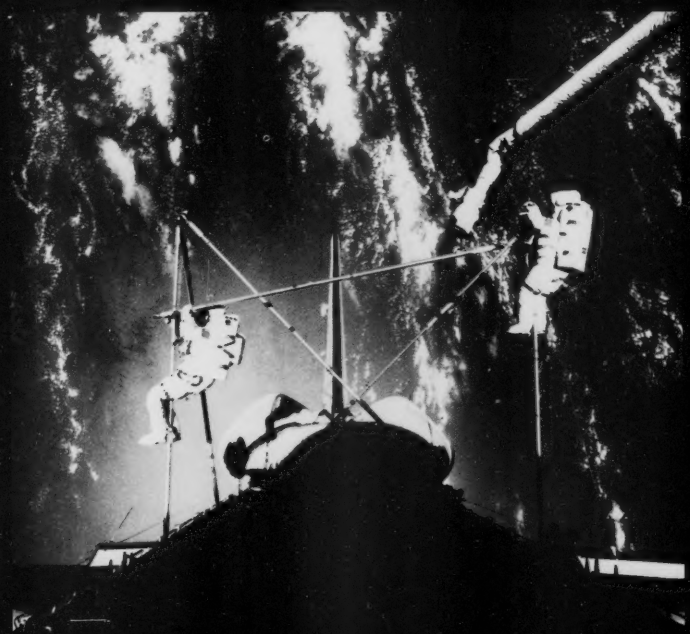
(Above) Although the Jupiter-bound Galileo spacecraft took these pictures of asteroid Gaspra during its close fly-by on October 29, 1991, the spacecraft did not transmit the data back to Earth until late November 1992. The montage shows Gaspra growing progressively larger in the Galileo camera's field of view, with the farthest view taken from a range of 164,000 kilometers and the closest taken from only 16,000 kilometers away. The 17-kilometer-long asteroid can be seen to rotate in the more than five hours that elapsed between the first and last pictures. Galileo flew past Earth for the second time on December 8 to set a course for Jupiter.

Apart from the busy schedule of science experiments on this eight-day U.S./Japanese mission, the STS-47 flight was most noteworthy for its crew, which included the first Japanese citizen to fly on the Shuttle (Payload Specialist Mamoru Mohri), the first African-American woman in space (Mae Jemison), and the first married couple assigned to the same space flight (Mark Lee and Jan Davis). Shown inside the Spacelab are (from the foreground): Jemison, Lee, Robert Gibson, Davis, Curtis Brown, Jr., and Mohri. The picture was taken by astronaut Jerome (Jay) Apt.

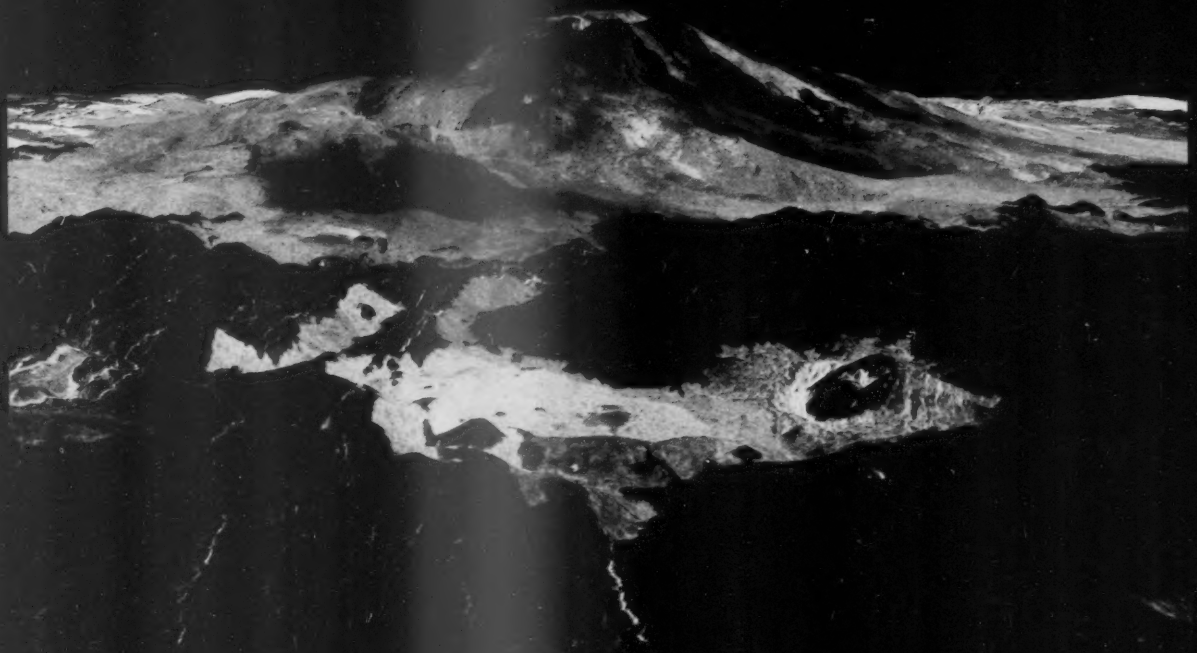
One of the most dramatic moments in the history of the Shuttle program came on May 13, when astronauts (from left) Richard Hieb, Thomas Akers and Pierre Thuot successfully grabbed onto Intelsat VI in Earth orbit with their gloved hands. It was the third attempt by the STS-49 astronauts in four days to rescue the $131 million satellite, and the first three-person spacewalk in history. After a quick repair, Intelsat was boosted from the Shuttle altitude to its operational "home" in geosynchronous orbit.

Among the many discoveries made by the Hubble Space Telescope in 1992 was this image of a giant disk of cold gas and dust fueling a suspected black hole at the core of galaxy NGC 4261, in the Virgo cluster. The disk measures some 300 light-years across. Although the Hubble image does not prove the existence of black holes, the telescope's unmatched resolution has provided scientists with their clearest view yet of the center of an active galaxy where a black hole is thought to reside.

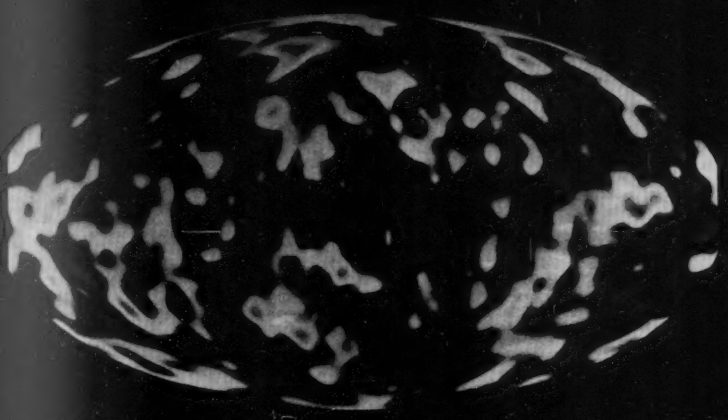
The first American spacecraft to head for Mars since the mid-1970s, Mars Observer was launched September 25 with a new Transfer Orbital Stage booster (shown in this artist's conception) attached. After Mars Observer arrives at its destination in August 1993, it will orbit high over the Martian poles, conducting a comprehensive and detailed study of the planet's atmosphere, surface and interior over the course of one full Martian year (687 Earth days).



On the same STS-49 Shuttle mission that featured the dramatic rescue of the Intelsat VI satellite, astronauts Thomas Akers (left) and Kathryn Thornton did the first space construction work since the mid-1980s. The tests, called ASEM (Assembly of Station by EVA Methods) helped Space Station Freedom planners evaluate methods for building the Station in the late 1990s. STS-49 also was the maiden flight of NASA's newest Shuttle orbiter, Endeavour.



By year's end, the radar-equipped Magellan spacecraft had mapped 99 percent of the surface of Venus in unprecedented detail, and was closing in on the end of its spectacularly successful mission. The knowledge gained since the spacecraft began mapping Venus in 1990 has revolutionized our understanding of the second planet from the Sun. Here, Maat Mons rises nearly five kilometers above the surrounding terrain in a computer-generated, three-dimensional view of the surface of Venus based on Magellan data.



This map of the microwave sky, produced from a year's worth of data returned by NASA's Cosmic Background Explorer (COBE) from Earth orbit, shows whispers of the Big Bang itself. For the first time, the extremely faint radiation left over from the very early universe was observed directly by the COBE satellite, which was launched in 1989. Lighter areas show temperatures very slightly warmer than the sky average, while darker areas show temperatures that are colder. The COBE data lend support to the Big Bang theory, and have been hailed as one of the most important cosmological discoveries of our time.

Johnson

The Gang's All Here

Russian cosmonauts Sergei Krikalev and Vladimir Titov are now training with their American counterparts at the Johnson Space Center for next fall's historic STS-60 Space Shuttle mission. The families of the cosmonauts arrived in Houston in November, where they were expected to have some difficulty adjusting to new roads, stores and schools. Meanwhile, the cosmonauts expressed enthusiasm about their ongoing training schedule.

The mission crew, to be led by veteran astronaut Charles Bolden, will orbit the Earth onboard Discovery for eight days. During the flight, the international crew will test a new wake shield facility (expected to create an ultravacuum for materials processing), use the Spacehab middeck extension module, and conduct joint U.S.-Russian experiments. •

(JSC photo/Bob Walck)

Russian cosmonauts Sergei Krikalev, left, and Vladimir Titov, right, share a team handshake with future crewmate and STS-60 pilot, Kenneth Reightler.

Wallops

CSOAR Soars

In September, the first student-built, student-managed payload to fly on a NASA sounding rocket was launched successfully from the Wallops Flight Facility. The project, a joint venture between NASA and two Space Grant Consortiums in Colorado and Virginia, is known as the Colorado Student Ozone Atmospheric Rocket (CSOAR). Aside from measuring ozone density in the atmosphere, CSOAR demonstrated how sounding rockets could be used as a valuable educational tool for undergraduate and graduate students.

Greg Essmeier, a student from Colorado State University at Fort Collins, called the launch "amazing, beyond words." Elaine Hansen, Director of the Colorado Space Grant Consortium, said, "This is like winning the Super Bowl the first time you try."

The CSOAR payload was carried aloft by a NASA single-stage Orion sounding rocket.

The CSOAR student-built payload heads for the wild black yonder.

After reaching a 53.9-kilometer altitude in 116 seconds, the payload descended by parachute into the Atlantic Ocean, where it was recovered by the U.S. Coast Guard from Chincoteague, Virginia. •

Lewis

The Fibers are Flying

A new fiber optic sensor system that offers major improvements in aircraft flight control flew successfully on a NASA research aircraft in October. A joint effort of the Lewis Research Center and John Carroll University, the sensor system measures engine throttle position. Because fiber optics are immune to electrical interference caused by lightning, radar, and other strong radio sources that can disrupt a plane's electronic control systems, they are expected to be more reliable than electrical components. The sensor system was flown on NASA's F-15 aircraft at the Dryden Flight Research Facility in California, where it flawlessly tracked through all maneuvers, including snap accelerations and decelerations. The research is part of the Fiber Optic Control System Integration Program, managed by Lewis, which is working to develop and demonstrate a fiber optic propulsion and flight control system for advanced aircraft. •

Stennis

Satellite Sleuth

The law has been using fingerprints to catch criminals for years, but now NASA remote sensing technology is being used to develop "fingerprints" for ships that fish illegally in the Bering Sea. Under an Office of Commercial Programs project managed by the Stennis Space Center, NASA is working with two Washington state companies on an Earth Observations Commercialization/Applications Program (EOCAP), to develop an ocean surveillance system that could help crack down on illegal fishing in the region. Costs associated with this illegal fishing can exceed $1 billion each year.

Satellites could help crack down on a billion-dollar poaching problem in the Bering Sea.

In an operational system, which the NASA/EOCAP project expects to bring into service within three years, a NASA satellite orbiting 910 kilometers above the Earth would send detailed digital snapshots of the Bering Sea down to ground stations. There the data would be used to come up with a computer "fingerprint" for each vessel, based on the condensation of water vapor on sulfur particles in their diesel exhaust. Each ship produces a unique pattern, and the prints of U.S. vessels fishing in the Bering Sea would be entered into a computer. That way, foreign ships encroaching illegally on the 320-kilometer U.S. fishing zone would be easy to identify. The information could then be passed on to a Coast Guard cutter or spotter aircraft, which would make enforcement efforts more efficient. •

Dryden

Mr. Goodwrench

Billy Furr

Dryden Research Center's Billy Furr, an aircraft mechanic who started working at the center in 1956, has seen just about everything in his 36 years at Dryden. Since his first assignment working on the B-29, he's tooled around almost every kind of aircraft there is, including the YF-12, the F-102, F-100, F-111, F-14, XV-15 and X-29.

His real love, he says, was the YF-12, prototype of the high-flying SR-71 "Blackbird." "The SR-71 is still a joy," he says. "To me, there's no other bird."

Furr remembers the time he had to spend six months fixing external leaks on that bird. "I think three of those months were spent inside the fuel tanks. Sometimes you had to be a contortionist to get to places to do the work."

A graduate of Reedley College (now King's River College near Fresno), Furr started his career at Dryden at the age of 18. "I graduated on a Thursday night and came to work on Monday morning," he said.

These days Furr divides his time between several projects, including the X-31 and the AFTI/F-16. •

JPL

Turn Up the Power

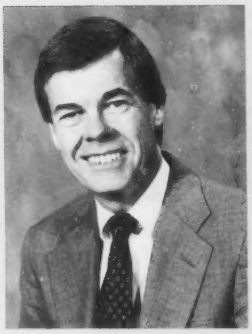
The Jet Propulsion Laboratory is joining up with Cray Research, Inc., to participate in the High Performance Computing and Communications Program, a bold new multi-agency initiative to advance U.S. capabilities in supercomputing. Engineers from JPL will be involved in joint research and development activities using Cray's most powerful supercomputer, the Cray T3D. JPL was chosen as a site for Cray's "center of excellence" program because of the great expertise developed at JPL and Caltech in parallel computation.

The computer will be located at JPL, where it will be used for a number of high-power applications, including: turning planetary spacecraft data into three-dimensional animations; electromagnetic simulations for the design of communications antennas; analyzing Earth satellite data; studying the dynamics of chemical reactions and the flow of space plasmas; and computational fluid dynamics. •

Goddard

Radar to the Rescue

Goddard Space Flight Center engineers are experimenting with a synthetic radar aperture system that could help rescuers find victims of airplane crashes more easily. The radar—the same type of device that Magellan uses to map Venus—is mounted on an airplane, and is able to spot debris that is almost entirely concealed. Rescue workers hope the new radar will ease their dependence on emergency transmitters to pinpoint crash sites. Although Goddard has been experimenting with synthetic aperture radar since 1985 and has tested the system successfully in six states, engineers say it will be two to three years before such a search and rescue radar system is operational. •



The space program is many things to many people. But on a long, solitary run in the shadow of the Space Shuttle, its real value comes clear: Space exploration is about reaching out, trying harder, dreaming and creating.

America is About Eagles

by Dr. Rick Chappell

Space exploration is at the heart of what is important for America. There are many reasons why: the case for an aggressive space program is not made in one sentence.

History tells us that those nations that reach out and explore will prosper, while those that turn inward will lose power and influence. Exploration leads to new knowledge and new technologies—knowledge about the universe around us and essential information about our planet's environment. The excitement and challenge of space are magnets for our children, attracting them to science and engineering and offering them careers that drive their creativity and innovation. Space exploration gives us all these things. And America must send a clear message to our young people about its commitment.

It has become my custom, when I'm involved in a Space Shuttle mission, to go out to the Kennedy Space Center on the day before launch to be near the vehicle alone. I usually park on the causeway, at the public viewing area, and take a long run with the Shuttle in view.

This particular day I parked near the bridge and ran to the west into the afternoon sun. When I reached the end of the causeway, I turned north on Static Test Road and ran directly toward pad 39A, where Atlantis was awaiting launch the next day.

As I ran, I gradually moved away from the sounds of the traffic on the causeway road and into the sounds of nature. There is a small canal near the road that was full of egrets, cranes, and an occasional spoonbill and alligator. Along the roadside in the grass, there were quite a few armadillos. They were amazingly oblivious and unaware of my passing. They were not concerned about what was going on around them, only about their next meal.

After running for quite some time, I felt that I should turn back, but found that it was difficult to turn away from the Shuttle. I would turn and run ten or twenty steps, then stop and look at it again, appreciating its beauty and feeling the significance of what it means for the United States and the world. The Shuttle represents our country's reaching out and creating. Along with the rest of the space program, it represents the best of America's accomplishments.

Finally I began to run again. Filled with the vision of the Shuttle and the emotion of space exploration, I asked myself, "Why is it that America should spend money to realize people's dreams of exploring space?" I answered that it's because of the space program's ability to drive people to create, to generate new technologies we can sell abroad. Clearly those investments are good for the economy, since they pay for themselves many times over.

Continuing to run, I passed another armadillo, then, as I looked up, saw an eagle. I was struck by the contrast of their different approaches to life. Whereas the armadillo never looks up and is oblivious to the world passing it by, the eagle soars quietly and majestically. It is not rooting around in the ground. It is striving for the high ground, seeking a vantage point from which it can see beyond the horizon. It is reaching out and flying in difficult places. Its vision is never limited.

I was reminded that America should explore space because America is not about armadillos, America is about eagles. America is about broad visions, about looking up and looking out, about flying high and flying free, about creating, about doing things because they are hard, about reaching out to lead in new places, and about drawing out the best of our talents to accomplish our dreams.

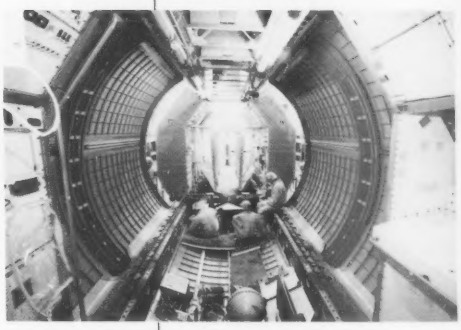
America is about eagles. •

Rick Chappell is Associate Director for Science at the Marshall Space Flight Center.

LAUNCHES

• STS-55—Spacelab D2 will be the cargo bay payload on Space Shuttle Columbia.

• STS-56—Space Shuttle Discovery will deploy the Atlas 2 satellite.



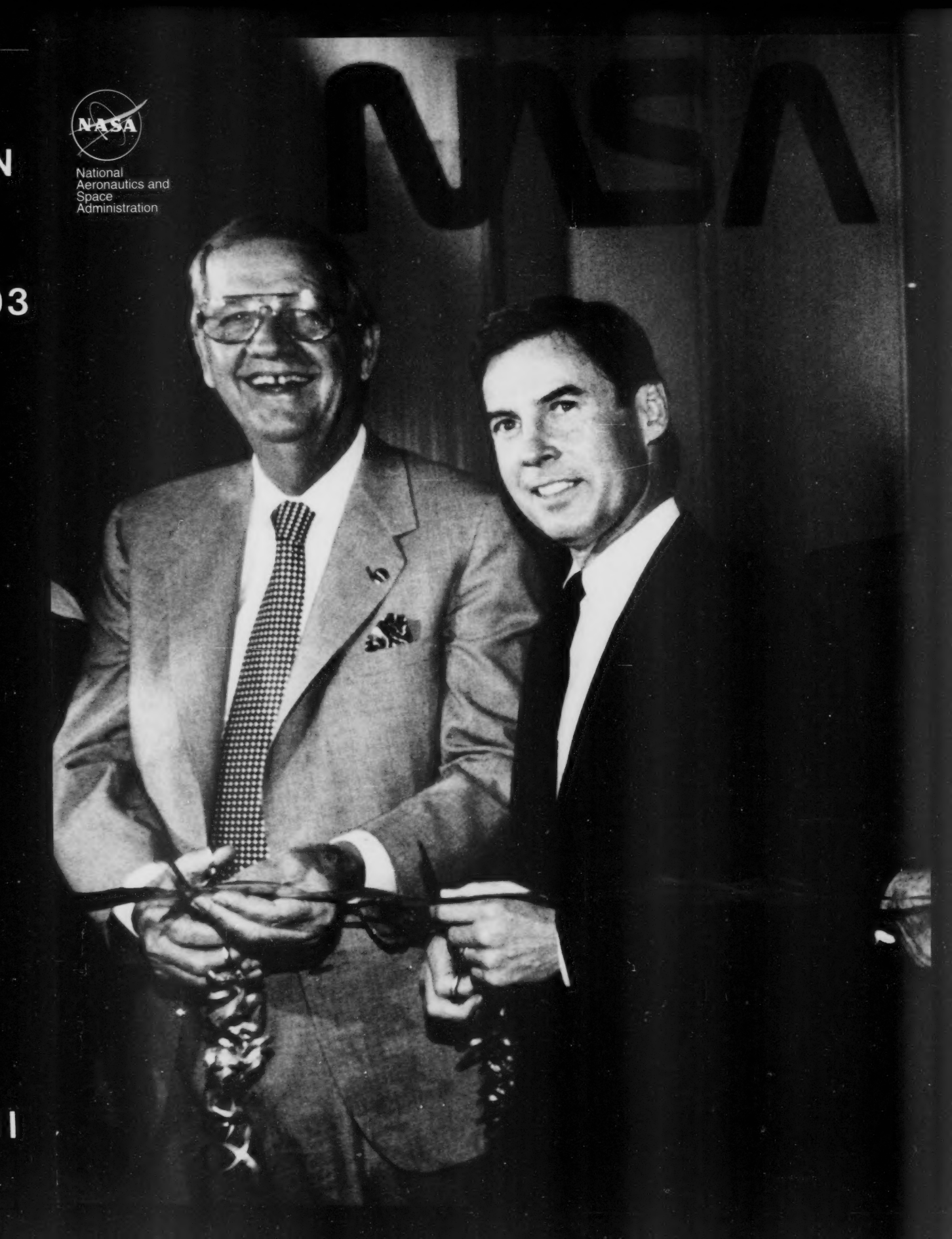
EVENTS

1
APRIL

Tiros 1, the first successful weather satellite, was launched 33 years ago. Tiros 1 transmitted 22,952 good quality cloud cover photographs.

IN OUR NEXT ISSUE

For the kids who attend the Anton Grdina school in Cleveland, Ohio, the work is out of this world, thanks to a lot of help from the Lewis Research Center.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